JOURNAL OF THE

SMPTE

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The Challenge of 8mm Sound Film

By JOHN FLORY

Just as paperbacks have enlarged the field of publishing, 8mm sound film, "another milestone in the communications revolution," may extend the boundaries of the motion-picture industry. Some major technical and economic obstacles must be overcome before the potential of 8mm for home entertainment, community service, religion, medicine, science, business and industry, government and education can be fully realized.

THE 8MM SOUND FILM, recently referred to by an eminent sociologist as "another milestone in the communications revolution," may broaden the perimeter of the motion-picture industry much as paperback books have affected the field of publishing. If present indications prove true, it is predicted that by the year 1976 there could be — world-wide — 15,500,000 8mm sound projectors in use. Therefore, it is timely to examine the major technical and economic obstacles to be overcome before 8mm can be of optimum usefulness for home entertainment, community service, religion, medicine, science, government, business and industry, and education.

At the outset, it can safely be predicted that from now on the growth of the use of 8mm sound film will greatly exceed the rate of increase of 16mm usage.

Figure 1 shows the growth in the use of 16mm sound projectors in the United States to an estimated total of 727,000.

It will be recalled that the first commercial 8mm sound-on-film projector was the Movie-Sound-8, offered to the public by the late Lloyd Thompson and several of his associates of the Calvin Co. nearly a decade ago, back in 1952. The introduction within the last 24 months of such brands of machines as the Cirse (now called Filma), the Elite, the Fairchild, the Fujica and the Kodak Sound 8 would indicate that the time is now ripe for a successful breakthrough in the sales of 8mm sound projectors.

A scrutiny of the growth of the number of 8mm silent projectors in use in the United States reveals an estimated total, as of the first of this year, of almost 4,000,000 machines (Fig. 2).

A comparison of the estimated output of 16mm sound projectors manufactured annually in the United States over the last seven years with the output of 8mm *silent* projectors (Fig. 3) reveals that sales of 8mm machines are growing at a far more rapid rate than in the case of 16mm units.

(Figures for 16mm silent projectors are not compared with those for the 8mm silent projectors because the former type is rapidly becoming obsolete, except for special purposes.)

Presented on May 9, 1961, at the Society's Convention in Toronto by John Flory, Advisor on Nontheatrical Films, Eastman Kodak Co., 343 State St., Rochester 4, N. Y.

(This paper was received on June 28, 1961.)

16mm Projector Sales Statistics

It is believed that around 49,000 16mm sound projectors were made in the United States in 1960, in contrast to around 683,000 8mm silent units. From this, it may be hazarded that the sale of 16mm sound projectors, despite a current bulge resulting from the National Defense Education Act, is soon likely to reach a plateau of maturity. The *rate* of sales growth (not to be confused with the total number of units sold) will perforce increase far less rapidly from now on in the case of 16mm sound projectors than will the *rate* of growth of a newer product, such as the 8mm sound-on-film projector.

After all, the nearly ¾ million 16mm sound projector owners now in the United States are already sold on the efficacy of the film medium. If it can be proved that there are some major advantages to 8mm sound, then certainly

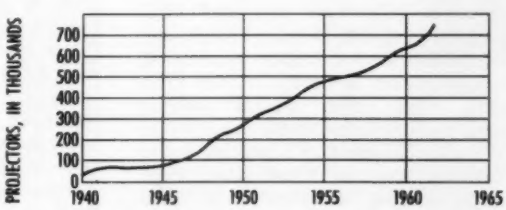

Fig. 1. Estimated number of 16mm sound projectors in use in the United States as of January 1, 1961.

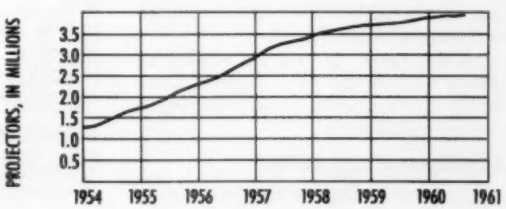

Fig. 2. Estimated number of 8mm silent projectors in use in the United States as of January 1, 1961.

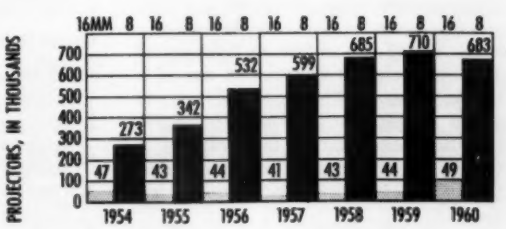

Fig. 3. Comparison of rate of manufacture of 8mm silent projectors vs. 16mm sound projectors in the United States during the last seven years.

it would seem that we shall not have to wait so many years before we have ¾ million 8mm sound projectors in use. This will be especially true if 4 to 5 million amateurs can be persuaded to convert to 8mm sound, and if somehow the price and quality of the new machines can be made sufficiently attractive.

The Challenges of 8mm Problems

At this point, the industry is faced with a pitfall. In an effort to bring the price of the 8mm sound system down, manufacturers must not yield to the temptation to sacrifice quality. Poor quality 8mm sound projectors, striping and release prints could kill the medium before it even gets properly launched.

This presents serious engineering and technical challenges. By and large, it is much harder to build a good 8mm sound projector than a 16mm counterpart. An analogy might be the fact that a wristwatch requires closer tolerances and greater skill to build than does a large, kitchen alarm clock.

For a number of years, it was generally felt that the slow linear speed at which 8mm film travels would make it impracticable to add a soundtrack. The advent of improved magnetic recording techniques has furnished engineers with considerable experience in the design of magnetic-tape recorders. This was helpful in the early stages of the development of an 8mm sound-on-film motion-picture projector employing a magnetic track.

The paper by John A. Maurer on later pages of this *Journal* deals with the problems of adding sound to 8mm by means of the traditional, photographic-optical soundtrack. Likewise, developments in 8mm have depended upon progress in motion-picture photographic emulsions. Present image quality of emulsions such as Eastman Color Print Film, Type 7383, permits multiple release prints of commercial acceptability at a price considerably below that where Eastman Reversal Print Film, Type 5269, is used. Black-and-white 8mm prints, because of improved grain structure, are feasible today; they were not at the end of World War II.

At this point, it may be helpful to review some of the advantages of 8mm sound film which its proponents feel it can eventually offer.

Advantages of 8mm Sound

The greatest single argument in favor of 8mm sound is that the small-size 8mm film represents what potentially could be great economy in film cost. Because the 8mm (0.143 by 0.196 in.) frame is approximately one-quarter the size of a 16mm frame (0.294 by 0.412 in.), it would appear that an 8mm film should cost only one-quarter the price of a 16mm film of the same screen running time. This is obviously "par for the course."

In actual practice, there are a number of factors which, at least at the outset, make it difficult to effect such economies at this stage in the development of the medium. Here are some of the principal advantages often cited in favor of 8mm sound films:

1. economy of release prints,
2. lower-cost projectors,
3. less-bulky prints (an advantage when carrying, storing or shipping),
4. smaller-sized projectors,
5. lighter-weight release prints (an advantage in an age of air transportation),
6. more portable projection equipment — less weight,
7. improvement in looping performance (of motion pictures in connection with continuous-running or repetitive projectors) and
8. self-threading or cartridge-load mechanisms to become more feasible.

The full potentialities of 8mm sound film will not come to fruition, however, until a wholly new 8mm system is perfected. This must offer the public:

(a) quality, low-cost projectors.

(b) quality, inexpensive release prints.

(c) quality, low-cost methods of making reduction prints.

(d) quality, low-cost methods of original production in 8mm for informal subjects, with satisfactory duplicates, in moderate numbers, obtainable.

(e) new print marketing and distribution setups.

Optical vs. Magnetic Sound

As any new field begins to develop, there are always a number of different paths by which progress can be made. It is always a problem for the pioneer to choose the path that seems, at the time, to be the most promising.

The manufacturer who contemplates marketing an 8mm sound-on-film projector must make a "command decision" early in his thinking as to the relative merits of 8mm optical sound vs. those of 8mm magnetic sound. At the present time, the fact that manufacturers of several makes of machines have all chosen to use the magnetic soundtrack method may have been brought about by the following factors:

Optical Sound Advantages:

1. Optical release prints inherently less expensive than magnetic-striped prints.
2. No danger of soundtrack erasure.

Optical Sound Disadvantages:

1. More difficult to achieve good quality soundtracks.
2. Better quality laboratory processing required for optical prints — finer tolerances.
3. Optical projectors not primarily suited for those who want to show their own homemade motion pictures as well as run professionally produced products.

Magnetic Sound Advantages:

1. Magnetic sound opens up the vast amateur market.
2. Good quality magnetic sound easier to obtain.
3. Soundtracks can be readily personalized to suit a specific audience, and can be translated at less expense into a needed foreign language — particularly where fewer than six release prints are needed.

Magnetic Sound Disadvantages:

1. Theoretically, magnetic prints cost more than optical prints.
2. Danger of accidental erasure.

Economic Potentialities of the Amateur Cine Market

In the United States, it is generally felt by the trade that unless a family has an income of at least $5,000 a year, it is not normally a good prospect for amateur cine products. At the present time, there are about 30,000,000 families with an income of $5,000 and upward per year. This represents 56% of the family purchasing units in the country.

It is estimated that there are now approximately 5,300,000 amateur cine cameras in use in the United States and about 4,000,000 silent-8 projectors.

Any appreciable penetration of the amateur cine market with 8mm sound projectors would seem to require a machine that permits the amateur to add sound to his personally made motion pictures. The complexities of optical sound recording are such that most leaders in the industry doubt whether the average amateur would be able to cope with the technical problems of recording sound through traditional, optical photographic methods. The large number of ¼-in. magnetic-tape recorders being sold annually in the United States (425,000 units in 1960) indicates that the layman is able to record voice messages on tape without too much trouble.

It is obvious that considerable sales resistance would be encountered if two incompatible types of sound projectors were needed in every home — one capable of magnetically recording and reproducing the customer's own pictures and the other able to reproduce only professionally made films available with optical soundtracks.

In the case of 16mm combination magnetic-optical sound projectors, it has been found that a dual-purpose machine is considerably more expensive than a single-purpose unit. The demands for the lowest-possible-cost machine in order to penetrate the home market would seem — at the present time — to preclude the successful introduction of

8mm sound projectors having a dual (optical as well as a magnetic) capability.

It has been suggested that while magnetic projectors would satisfy the home market, 8mm optical units would be preferable for educational, industrial and other institutional uses.

This is the point at which the manufacturer is faced with a major policy decision as to the type of machine he will espouse. Even though it is more difficult to make a high-quality 8mm sound projector than its 16mm counterpart, the public — because of the heretofore lower cost of the home 8mm film medium — has come to expect that 8mm machines will be priced at considerably less than 16mm equipment.

The television industry long since discovered that until it could offer a satisfactory receiver costing the customer $200 or less, it was not able to generate mass sales.

Thus, many leaders in the photographic industry feel that mass sales of 8mm sound projectors will ultimately depend — if the amateur market is to be exploited — upon the industry's ability to turn out a satisfactory-quality unit in the neighborhood of $200 or even $150. At the present time, this does not appear to be imminent.

On the other hand, it would seem desirable to settle upon the type of apparatus which promises ultimately the largest potential sales.

It has been said that until an American manufacturer can turn out upward of 250,000 units per year of a single piece of apparatus as complicated as a sound projector, it does not pay him to automate the manufacturing process, and he cannot avail himself of those economies that derive only from mass production.

Considering that 16mm sound projectors have been on the market for 28 years in the United States, and now are manufactured industry-wide at the rate of only 40,000 to 60,000 machines per year, a single manufacturer would have to make five times as many machines as the entire industry is now turning out in order to lift the building of sound projectors to a truly mass-production basis.

On the other hand, the U.S. photographic industry is currently manufacturing 8mm silent projectors at the rate of an estimated 683,000 units per year.

It would seem, therefore, that somehow the manufacturing of 8mm sound projectors must be conducted on a scale comparable to that which now prevails in the case of silent units, if the ultimate economies are to be achieved.

As a corollary to mass production, however, is the matter of mass sales. It is at this point that it would appear logical to emphasize a type of machine which will have universal applications in the amateur, as well as the professional, phases of the nontheatrical film field.

Need for Low-Cost 8mm Prints

Here we are faced with another dilemma.

It is obvious that the rate of institutional purchases of 8mm sound projectors will depend, to a very considerable extent, upon the availability of professionally produced films in the 8mm width.

This "chicken-or-the-egg" dilemma is accentuated by the fact that many producers of professional motion pictures are reluctant at this point to enter the 8mm field. They hesitate to invest in 8mm preprint materials, an inventory of 8mm preview and release prints — and even more important — a whole new marketing approach, until there are enough 8mm sound projectors out in the field to provide a ready-made market.

In other words, the 8mm sound projector is not an isolated piece of apparatus. It is merely one important component of an entirely new system of screen communication. Until all the other components are properly introduced, the system will not function with maximum effectiveness.

Right at the moment, the chief bottleneck to wider adoption of the 8mm sound-film system is the difficulty of getting high-quality, low-cost release prints.

Other papers in this group of papers about 8mm film indicate some of the problems which must be overcome to achieve this; they also indicate the rapid progress that has already been made.

It is becoming apparent that those of us who would engage in exploring the potentialities of 8mm sound film must set our sights high. We must be willing to accept wholly new concepts insofar as the magnitude of the market is concerned. Anything less is doomed to failure. Eight-millimeter sound film has no real merit unless a way can be found to deliver onto the screen a moving image in color, with concomitant sound, which is not too inferior to that which up until now has been delivered by the average 16mm sound projector.

Furthermore, both the laboratory cost of release prints and the ultimate retail sales price must be drastically less than is now the case for traditional 16mm prints.

At the present time, large sponsors of business motion pictures probably require an average of about 100 prints of each of their major motion-picture subjects. One large distributor of sponsored films feels that at least between 400 and 500 prints are needed to secure national 16mm audience saturation within a period of 12 to 24 months.

In the case of nonsponsored educational films for the school market, a total of 400 to 600 prints — over at least a five-year marketing period — is probably the number of prints required by the distributor of an averagely successful classroom motion picture. (It is an unusual school picture that sells over 2,000.)

There are, of course, cases where sponsors have used as many as 5,000 prints, and where a nearly equal number of prints of a nonsponsored classroom film have been purchased by those film libraries catering to the school market. Nonetheless, looked at as a whole, 500 prints of a single production is a generous average sale for the present 16mm nontheatrical film field in the United States.

(By way of comparison, it should be noted that the *Film Daily Yearbook* for 1957 indicated that the average number of prints required for a feature picture, made by a major company, was 300.)

If 8mm sound film develops into the mass medium that its proponents predict, it will be necessary to think in terms of 5,000, 10,000, 25,000, 50,000, and even 100,000 release prints of a single production.

A wholly new marketing pattern will have been created to produce sales of this magnitude. Already, some distributors are exploring the economic and merchandising problems that are involved in creating thousands of fresh sales outlets for the new, narrow-gage, low-priced prints. Camera stores, supermarkets, phonograph-record shops, drugstores, sporting-goods houses, department stores and aggressive direct-mail compaigns are being contemplated as some of the avenues for achieving volume print sales on a scale almost comparable to the paperback book publishing field — where a minimum run of 250,000 copies is the usual practice.

Obviously, production costs, when amortized across sales of this magnitude, can be reduced to a comparatively minor amount per individual print. Distributors will then demand that marketing expenses and laboratory release-print costs be kept to the lowest possible figure per unit sold, for that is where their future profits lie.

The competitive pressures of such mass printing of 8mm sound release prints will inevitably bring about a technological revolution in motion-picture laboratory release-printing practices. There are indications that once a descending cost spiral begins to come into effect, the base of nontheatrical motion-picture film usage is destined to broaden at an astounding rate.

Market Opportunities for 8mm Sound

For example, last year American business and industry spent a total of $11.7 billions to advertise its products and services. Of this, the majority was aimed at the consumer market. The

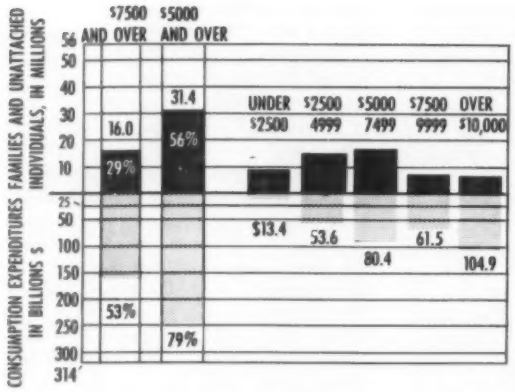

Fig. 4. Distribution of income and spending in 1959. (Based on Survey of Current Business, April 1960.)

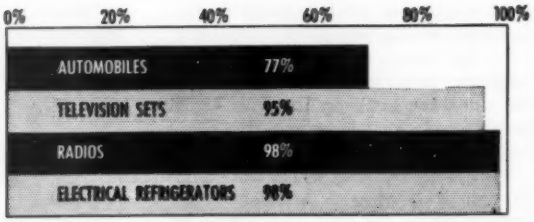

Fig. 5. Ownership of automobiles and household electrical equipment by U.S. families of $5,000 annual income and up. (Sources: 1961 EM Week; Federal Reserve Survey Consumer Finances.)

U.S. consumer market, after taxes, represented annual purchases of $314 billions in 1959. Figure 4 indicates the pattern by which purchases were made by various income groups in 1959 (the most recent year for which income distribution data are available).

It will be noted that families having an annual income of $7,500 per year and up account for 53% of all the consumer goods and services sold in the United States. It is these families that are first likely to become owners of 8mm sound projectors.

If we look at that segment of the population which has an annual income (often because of two or more wage-earners in a single family purchasing unit) of $5,000 per year and up, we find that this group accounts for 79% of all consumer purchases. This 56% of the families represents the most logical potential owners of 8mm sound projectors. At the present time, 95% of them already own one or more television sets; 77% of them own one or more automobiles; 98% of them own radios; 98% own electric refrigerators (Fig. 5).

A further analysis of American consumer advertising budgets indicates that they are primarily directed at Mrs. Housewife. She is, except for certain mechanical equipment and major items, by and large the purchasing agent for the American family. At the present time, it is extremely difficult for the sponsor of a business film to get his production seen through 16mm channels by a significant number of Mrs. Housewives.

It is estimated that there are over 1,000,000 clubs and other organized groups, of 50 or more members each, which hold regular monthly meetings and which theoretically are potential audiences for nontheatrical motion pictures. Presently, the sponsor of a business film finds it difficult to reach many of the most desirable of the women's clubs unless they are closely affiliated with a Parent Teachers Association, a church or a Grange. That is because ownership of 16mm sound projectors is, at present, largely restricted to institutions. Women's groups closely oriented to a school, to a church or to a rural Grange hall do have ready access to projection facilities.

On the other hand, hundreds of thousands of other women's groups are not self-equipped insofar as projectors are concerned. Perhaps some indication of future trends can be had through an analysis of the extent to which women's clubs use 2 by 2 color slides. Apparently enough 2 by 2 slide projectors are owned by individual club members to make it possible for many of the clubs to include slides on their regular programs. They use a machine brought to the meeting from home by one of the members.

Limited experiments conducted by the Boy Scouts a few years ago concerning the use of silent 8mm movies for Cub Scout activities indicated that Den Mothers found it relatively easy to supply their own machines when needed.

Thus, it would seem logical to assume that if 8mm sound projector ownership ever reaches as high as 25% of the U.S. homes which can afford them, the sponsors of promotional films, producers of for-sale educational and documentary films and distributors of Hollywood, entertainment-film productions will, for the first time, be in a position to sell and to circulate their product in a vast, new, and highly lucrative market. The large number of school, television and entertainment film subjects which could be revamped and adapted for this new audience is a further factor pointing to the eventual opening up of the field.

Vast Potential International Market

Throughout the world there are many less-developed countries which are desperately anxious to use the sound motion picture for purposes of education, enlightenment and economic advancement. The drastically low purchasing power of individuals and institutions in many of these overseas countries has, up until now, prevented the maximum utilization of the — for them — too expensive 16mm medium.

The capability of 8mm sound projectors of handling magnetic-striped tracks will very definitely prove to be a significant factor in opening up areas of the world which until now have been held back, through the barrier of language, from using nontheatrical films to any great extent.

World statistics on the nontheatrical film field are largely inaccurate or impossible to obtain. There are indications, however, that the Free World outside of the United States may, at the present time, be using almost the same number of 16mm sound projectors as are in use in the United States. In other words, if by the middle of this year there are approximately 750,000 16mm sound units in the United States, the Free World's total is probably close to 1,250,000 16mm sound units.

In the case of 8mm sound projectors, the tablecloth arithmetic might run something like this:

If there are approximately 30,000,000 American homes having an annual income of $5,000 annually and up, it is not unreasonable to hope that one-quarter of these families will become the owners of 8mm sound projectors by the year 1976. This would mean that U.S. homes would own 7,500,000 units.

Next, there is the nontheatrical film field consisting of business and industry, education, government, religion, civic, social welfare and recreation groups, etc., and medicine. At the present time, this is where most 16mm sound film is used.

Although 16mm will continue to be employed for large audiences, it is conservative to anticipate that the field will also, by 1976, be using at least four 8mm sound projectors for every 16mm machine now in use. Thus, the U.S. nontheatrical film field should account for an additional 3,000,000 8mm sound projectors.

On top of this, another 5,000,000 8mm sound projectors can possibly be anticipated for the rest of the Free World. Table I shows how this adds up.

"Milestone in Communications Revolution"

This, then, is the broad outline of what that very perceptive sociologist labeled "another milestone in the communications revolution." It is apparent that not only has Man entered upon a Space Age; he has also embarked upon

an era in which the motion picture is launched on a growth period of stupendous proportions. Film and the moving-image are well on the way to overtaking the printed word as Man's most popular form of recorded information.

As all of us know, Man's road to the stars is won only through hard work, increased engineering achievements, and at the cost of many failures along the way. In the same manner, there are many obstacles to be hurdled before 8mm sound film becomes an unqualified success.

The need is here!

Teachers clamor for a system which will allow youngsters to check out film prints from the school library and run them at home in preparation for the next day's classes. Great refinements in projector threading, reliability and screen brilliance are demanded daily. Church groups seek some satisfactory answer to motion pictures sufficiently economical to be used in graded Sunday Schools. Doctors and scientists are becoming excited, as witness the recent formation of the American Science Film Association, about the motion picture as an everyday tool to use alongside the slide rule and the computer in their research activities.

Business leaders faced with rising labor costs are desperately using audio-visual means to improve worker productivity and to expand overall company sales and profits. Government leaders all over the globe are calling for bold new uses of the motion-picture medium to interpret and to disseminate programs and messages of official importance.

Where is that complete college curriculum on 8mm sound film and teaching machines which can be airlifted to the jungles of Africa and Latin America, or to the Near East?

Table I. Predicted Total Number of 8mm Sound Projectors in Use by 1976.

Location	Units
U.S. Home Cine . . .	7,500,000
U.S. Nontheatrical . .	3,000,000
U.S. Total:	10,500,000
Overseas Free World . .	5,000,000
Total	15,500,000

With such a potential market in the offing, present engineering problems no longer seem quite so difficult or expensive to solve.

Already, educators are pointing out that today's educated citizen must be filmicly literate too. Our children will discover that the mark of an Educated Man is not only that he can handle his native language in written and spoken forms with finesse, but that he can also express himself in the international language of the film and of the moving image.

Early 8mm Sound Developments

By WILLIAM D. HEDDEN and KENNETH B. CURTIS

Although increased interest and activity have been shown recently in the use of 8mm sound films, following the introduction of several 8mm sound projectors, much research and development had been done in the past by those interested in 8mm films. This paper presents a historical résumé of the work of the late Lloyd Thompson and some of his early developments. Particular attention is given to the sound projection equipment that he introduced and to some of the film procedures that he utilized to make release prints.

IT IS WELL KNOWN that one of the leading pioneers in the development of the 8mm field was the late Lloyd Thompson, former Vice-President of The Calvin Company. Even when 16mm was hardly established, Lloyd was experimenting with 8mm sound. Since his tragic death in December, 1960, it has been believed that some record of these early developments in 8mm might be both important and interesting to record.

Before discussing the 8mm work specifically, brief mention is necessary of Lloyd's technical background in 16mm. In 1932 Lloyd Thompson joined forces with Forrest and Betty Calvin who were then operating an advertising company. Thus began the production organization and laboratory known as The Calvin Company. This company was one of the first to utilize 16mm film as a commercial communications medium. Lloyd supplied the technical and engineering force to this organization. For the most part, 16mm laboratory equipment was practically nonexistent. Processing machinery, printers, sound recording equipment and laboratory production techniques were all designed, constructed and put in operation under his direction. An understanding of this background is essential to appreciate Lloyd's early 8mm efforts.

In the middle 1940's, The Calvin Co. was developing a considerable amount of amateur home motion-picture film. By then 16mm was an accepted industrial tool; however, Lloyd was greatly impressed at the very high ratio of 8mm to 16mm amateur film received. He wondered why there could not be sound for 8mm also.

In 1946 Lloyd formed the Continental Products Corp. to market an 8mm sound system that he had developed. This system was patterned after the Vitaphone System where a turntable played sound as a projector showed the picture. He synchronized the two by placing a 1000-cycle note on the disc running at $33\frac{1}{3}$ rpm. This tone started the projector which was threaded at a sync mark on the film. Synchronization was accomplished in this manner. A description of this projector* was published in 1947. The projector was designed so as to use a Kodascope 8-33 projector mechanism. This simplified Continental's manufacturing operation. (See Figs. 1–3.)

One other interesting point about this first Movie-Sound-8 should be mentioned. The projector was designed to operate at 16 frames/sec, as most 8mm work was done at that speed. Arrangements were made through Castle Films to release numerous film subjects for home consumption.

Records were made to accompany the pictures. Since most of these films existed as 16mm 24 frames/sec sound subjects, some method was necessary to convert the pictures to 16-frames/sec prints. Lloyd accomplished this by building a skip frame printer that skipped every third frame. Thus a 16-frames/sec print could be obtained with the normal sound on the disc. A few critical observers could detect this difference when the picture and sound disc were projected in synchronization; however, the arrangement generally was quite successful and very good synchronization was obtained.

The turntable operated at 78 and $33\frac{1}{3}$ rpm. The $33\frac{1}{3}$ speed was used for the Castle subjects and other subjects com-

Presented on May 9, 1961, at the Society's Convention in Toronto by William D. Hedden (who read the paper) and Kenneth B. Curtis, Calvin Productions Inc., 1105 Truman Rd., Kansas City 6, Mo.

(This paper was first received on April 3, 1961, and in final form on June 19, 1961.)

* Lloyd Thompson, "The Movie-Sound-8-Projector," *Jour. SMPE, 49*:463–467, Nov. 1947.

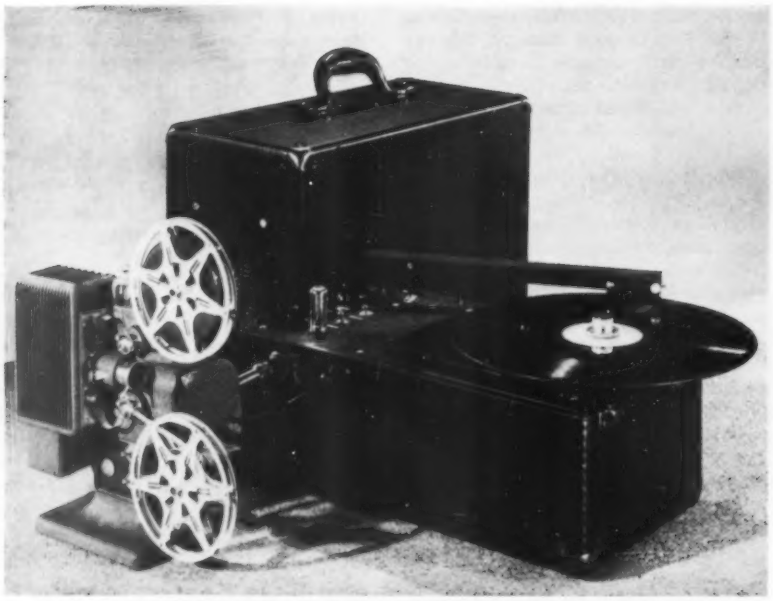

Fig. 1. Continental Products Disc Projector with turntable and case (speaker).

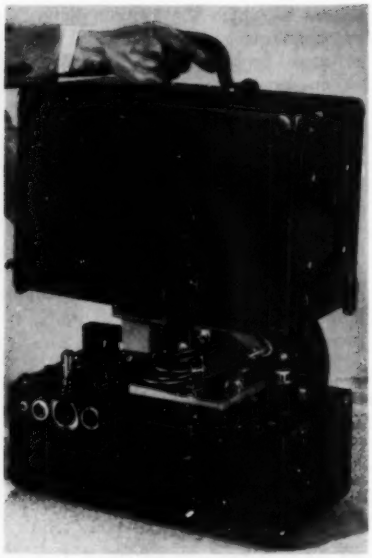

Fig. 2. Assembling speaker over projector showing portability of projector.

mercially produced, and the 78 speed for home records. It is interesting to remember that this was three years before the general introduction of 33⅓ records for home use.

About a thousand of these units ultimately were sold. Some mechanical defects, such as an underpowered motor, were present; however, the first rumors of magnetic striping in 1947 and 1948 indicated that an even better method of 8mm sound might soon be feasible. Magnetic sound would eliminate the disc and allow the amateur much more freedom for recording. Thus came the idea for the second Movie-Sound-8, the first 8mm magnetic sound-on-film projector to be introduced for sale (Figs. 4–6).

The Movie-Sound-8 was quite different from conventional 8mm projectors. In the design it was found impossible to use much of the conventional 8mm silent projector design as it simply did not work for 8mm magnetic. A good illustration was the drive motor. Universal-type motors with brush commutators were convenient but created too much noise. High-speed fans also were too noisy. For this reason a low-speed, constant-speed Bodine motor with fan was placed on the back of the machine as far away as was possible. This produced a very quiet-running machine.

The 1600-ft take-up reels provided are considered by the authors to be an important feature where industrial use is contemplated. This feature is not found on many current 8mm projectors. (The machine actually was capable of using 2000-ft 8mm reels if desired.)

Much work went into the magnetic sound system. Existing 16mm magnetic sound design was not satisfactory for 8mm, owing largely to greater sprocket flutter in the 8mm. Consequently, the Roto-Magnetic Stabilizer was invented and patented. This device was essentially a loose-loop and tight-loop system. A tight loop was used on the take-up side of the record-playback head, and a loose loop on the intermittent side. A unique flywheel and stabilizing design allowed the film to move quite uniformly over the magnetic head, producing good sound quality at either 24 or 16 frames/sec.

A two-channel amplifier was provided for recording purposes. Two signal sources could be mixed together, such as background music or sound effects and voice. Separate accessories also were available (Fig. 7).

Many of these features are relatively common today, but the significant and interesting thing is that this was basic research and development in the 8mm projector field, and that it was undertaken successfully a number of years before other similar projectors were introduced. Many of the reasons behind the engineering design are discussed in a rather basic 8mm treatise.†

Basically, the Movie-Sound-8 introduced in 1952 was quite similar to the 8mm sound projectors announced in 1960. The earlier disc projector was found to be a good proving ground for a number of features — such as 16- and 24-frame/sec operation which was included on the magnetic projector.

Stating simply that the 1952 projector was merely "introduced" is a gross simplification. Magnetic sound in

† Published in the PSA Technical Quarterly, February, 1954, and reprinted on the pages immediately following by permission of the Photographic Society of America.

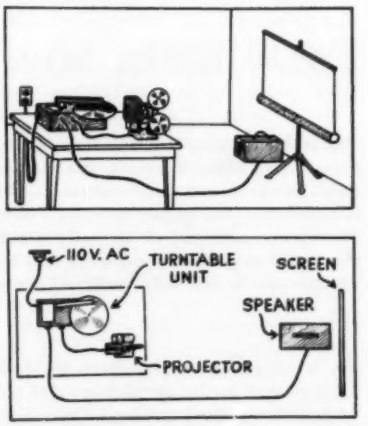

Fig. 3. Diagrams for use of Continental Products Disc 8mm Projector: (top) setup of projector, turntable and amplifier, speaker and screen; (bottom) schematic of setup.

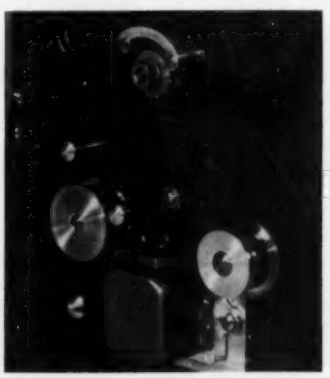

Fig. 5. Movie-Sound-8, magnetic soundhead.

1950–52 was in its infancy. Recording onto 8mm film having a stripe 0.025 in. wide with the magnetic materials and recording heads available in 1951 represented quite a contrast in effort to the same problem today. At that time, no commercial means for striping the 8mm film existed. Through numerous conferences with the Minnesota Mining & Mfg. Co., a magnetic laminate material suitable for 8mm as well as 16mm was made available.

Then came the means of applying this stripe to 8mm film. Much work was done with 3M in conjunction with this problem before 8mm striping was successfully accomplished. This illustrates but one of the problems that required a solution before film could even be used on the 8mm magnetic projector.

With magnetic striping possible and an 8mm projector available, a new consideration was raised. The first view of 8mm was largely for the amateur, but why could it not be used industrially? In the early 1950's much work was done at The Calvin Co. in learning the best method to produce 8mm magnetic sound prints from existing 16mm and 35mm subjects. It was believed that industry might use a small, lightweight, 8mm sound projector. Working with the Caterpillar Co., Peoria, Ill., The Calvin Co. converted a number of existing 16mm industrial subjects into 8mm sound prints for a trial by the Caterpillar Co.

The first attempt at making black-and-white prints was the obvious method of making a double 8mm negative, optically reduced from 16mm, then printing by contact and slitting the prints. Much printer design work on this method was undertaken and abandoned. All work pointed again to the slow, step-reduction method as the way of obtaining the best 8mm quality.

Much investigation went into laboratory developments to make 8mm sound prints from existing 16mm or 35mm productions. Various 16-8 and 35-8 step-reduction printers were constructed for this work. This investigation ultimately led to the development of a high-speed continuous 16mm to 8mm reduction printer also described at this time.‡

‡ See later pages of this issue.

Some interesting film problems arose from these 8mm laboratory investigations. For color, only the 5265 Kodachrome Duplicating stock was available at the time. In order to get color duplicates, step reduction from 16mm masters was about the only practical method to follow. This was slow and the resulting color quality was not very good. Had color positive materials been available then, the story would have been different. However, owing to the poor quality and slow production of color prints, most work was done in black-and-white.

One interesting discovery did lead to an important improvement in 16mm materials, however. It was soon found that the existing black-and-white dupe negative material, type 5203, did not have satisfactory resolution for 8mm work. Negatives were made with better success on master positive stock, type 5365. The best results were obtained, however, using Panchromatic Separation film perforated for 8mm. This film, when used as a negative, required a very short development time. The Eastman Kodak Co. has since introduced a material with a more normal development time, but with these same improved photographic characteristics. This is the current Eastman Fine Grain Panchromatic Duplicating Negative Film, Type 7234.

The Movie-Sound-8 magnetic projector was placed on the market in 1953 and production runs were made. In all, approximately 1200 units were sold. A very few mechanical deficiencies were noticed in mass production; however, these deficiencies could have been corrected quite easily had there been a continuing market for the machine. Several factors can be mentioned for the failure of this projector to realize a large market. Its price at that time was considerably higher than those of silent 8mm projectors, although it was well under the prices of 16mm sound models. However, the price was an obstacle. Also, it was found that the problems of advertising and marketing such a unit on a national scale were larger than could be undertaken at that time. These

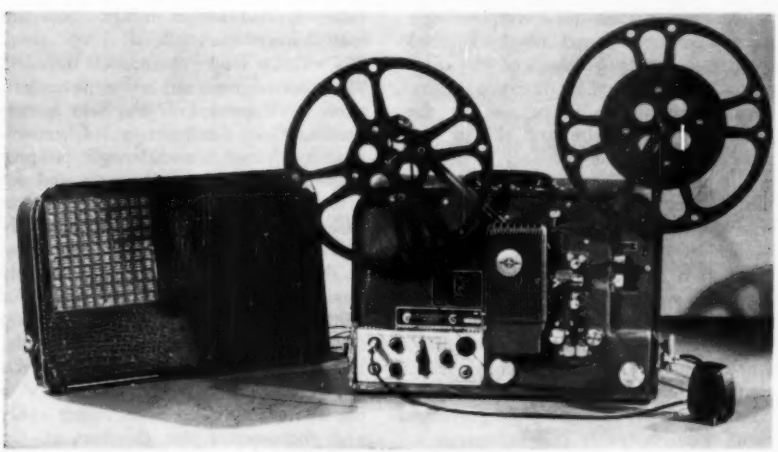

Fig. 4. Movie-Sound-8 — first magnetic 8mm sound projector.

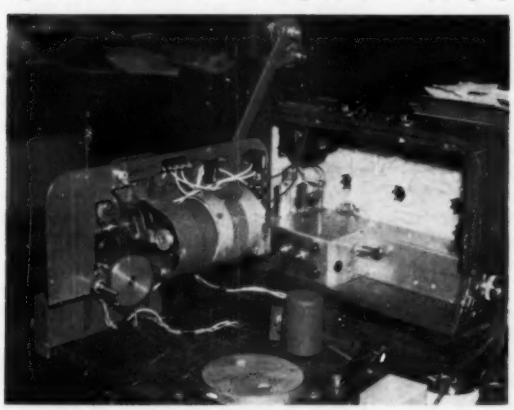

Fig. 6. Inside of Movie-Sound-8 showing motor, one sound-stabilizer flywheel assembled, second sound flywheel on bench.

Fig. 7. Accessories for Movie-Sound-8.

economic problems, rather than technical factors, limited the sale and use of the magnetic Movie-Sound-8. Several of these Movie-Sound-8 projectors are now used at Calvin along with current models for inspection of 8mm prints.

Shortly, it is hoped that much of the engineering data and other material concerned with Lloyd Thompson's early work on 8mm sound projectors will be collected under a suitable arrangement so that they may be preserved for use by the industry. It would be in keeping with his outgoing nature that this material be shared with anyone needing help in this field.

In closing, the authors of this paper wish to acknowledge the honor and privilege they enjoyed working with Lloyd Thompson. His work in this 8mm field ably illustrates his professional ability, pioneering spirit and personal integrity.

A REPRINT

Problems in the Design of an 8mm Magnetic Sound-on-Film Projector

By LLOYD THOMPSON

Users of 8mm motion-picture equipment have long wanted an 8mm sound-on-film projector. Optical type 8mm sound reproducers have proved impractical. The magnetic type of machine seemed to be more promising, for several reasons. With a magnetic sound-on-film projector the user can record his own sound as well as play it back, and this seemed to be a highly desirable feature for amateur film users. Also old silent films can be given a sound accompaniment after a magnetic track has been applied to the film. Magnetic tracks on 8mm films, however, impose their own problems in sound projector design. The 8mm film runs at a slower linear speed than does 16mm or 35mm film. Even when projected at 24 frames/sec its speed is only 18 ft/min. It was considered necessary to design a projector which would satisfactorily record and play back both at the slower silent film speed and at the current sound film speed. Such equipment would interest owners of old film who, by having a magnetic soundtrack striped on them, could add sound to the old films. The two-speed requirement complicated the design problem.

Another source of trouble was in guiding the film. Since the magnetic soundtrack is placed outside the sprocket holes on the margin of the film it can be no wider than approximately 0.025 of an inch. The film must be guided accurately so that the magnetic track will always line up over the record and playback head in the same position. The sound head could not be made wide, extending on both sides of the striping, because some of the magnetic coating might run over into the sprocket holes during application. This would introduce a great deal of sprocket "flutter" if a wide recording and playback head was used. Therefore, the recording and playback head was restricted 0.025 in.

The narrow track and correspondingly narrow recording and playback head require accurate guiding of the film and accommodation for different widths. Because 8mm film is exposed in the camera as 16mm film and slit in half after processing, the accuracy of slitting is not always maintained as it is in the film factory where the unexposed film was produced. Because of slitting inaccuracies and because of shrinkage, 8mm film is not always 8mm wide. A guide system to work satisfactorily has to take this fact into consideration.

Good results in magnetic recording, whether it be on film or tape, demand that the magnetic coating be in good contact with the recording and playback head. Film is rather stiff compared to cellophane tape, which is used for magnetic recording on most $\frac{1}{4}$-in. magnetic tape recorders. For that reason, it is a little more difficult to keep film in good contact with the head. Also different rolls of film will have different amounts of curl in them, so that a contact device must maintain contact even though there is a varying amount of curl in the film itself. Of course, if the film is damaged or there is too much curl in it, it may be impossible to get contact, but such films are in the minority.

The problem of flutter is very bad in 8mm film because the magnetic striping is placed along the outside edge of the sprocket holes. When the sprocket holes are punched in the film, there is naturally a deformation of the film at that point. If the usual method of putting the film around the sound drum is used on an 8mm magnetic film projector, sprocket hole flutter will be introduced in the recording and playback mechanism. A sound system has been developed to overcome the difficulties just mentioned. This system, described in a pending U.S. Patent, is called the Roto-Magnetic Stabilizer. It utilizes a principle which is called a combination of tight loop and loose loop system.

The loose loop system, used on early 16mm sound projectors and some modern ones, is capable of excellent sound results. One disadvantage of such a system, however, is a tendency to produce "wows" in the mechanism or in and out of focus with the light beam if the film has excessive curl. This difficulty was largely overcome by changing to what is known as the tight loop system that is widely used on sound projectors today. For 35mm and 16mm films the tight loop system seems to work quite satisfactorily, but when it is tried with 8mm film it gives difficulty. It has a tendency to damage the sprocket holes rather easily and, because of the closeness of the sprocket holes, it makes such a machine rather difficult to design so that it can be threaded properly.

The dual flywheel system of recording and playback is a tight loop system that gives very good results with 35mm and 16mm films but when used with 8mm film it seems to have certain disadvantages.

For those reasons, the Roto-Magnetic Stabilizer was designed to use the tight loop system only on the take-up side of the record and playback head. Between the intermittent and the record playback head the loose loop system is used. Such a system makes the projector easy to thread, it is easy on the film being handled, and it is comparatively simple to build. As shown in Figure 1 [see Fig. 5 in the preceding paper in this *Journal*], two drums are used as in the double flywheel arrangement. How-

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Reprinted by permission of Robert L. McIntyre, Editor, PSA Journal, from *Photographic Science and Technique*, PSA Technical Quarterly, February, 1954. The late Lloyd Thompson was Executive Vice-President, a co-owner and co-founder of The Calvin Company, Kansas City, Mo. This paper was adapted from a talk presented before the Motion Picture Division at the PSA National Convention in New York, August 12 to 16, 1952.

ever, on the Roto-Magnetic Stabilizer the double flywheels are used in a different manner. On the drum next to the take-up sprocket is mounted a rather large flywheel which floats on the shaft. It was necessary to use this rather large flywheel in order to get good film motion at the slow speed at which 8mm travels. It floats on the shaft to avoid injuring the film when the mechanism first starts. On the back of the other drum is a rather small flywheel. This tends to hold the film tight between the two drums as it goes over the record and playback heads.

The drum containing the large flywheel has been made with an edge guide and has been tapered slightly in manufacture so that the film has a tendency to run to the outside edge and against the guide on the edge of the drum. This means that the outside edge of the film containing the sound stripe is always in line with the record and playback head and this is done automatically whether the 8mm film has been slit oversize or undersize.

The other sound drum is covered with a rubber tire which has a tendency to grip the film so that the film is always held back at a uniform tension as it passes over the record and playback head. The intermittent motion is filtered out just before the film reaches this drum so that by the time it reaches the record and playback head there is no trace of the intermittent motion left in the film. Contact on the record and playback head and on the erase head is maintained with small rollers.

In building an 8mm sound-on-film projector, it was impossible to adopt very much of the conventional 8mm silent projector design. For example, most silent projectors have a universal type of motor with a brush-type commutator. Such a motor can be quite small and it also can be placed quite close to the rest of the operating mechanism on the projector. In an 8mm sound projector, it is impossible to do this because there is so much noise created by a brush-type motor or a governor-type motor. It is much simpler to use a motor without brushes than it is to try to get the noise out. Even so, the motor is likely to cause electrical disturbances and for that reason it is a good idea to get the motor as far away from the recording head as possible. A Bodine constant-speed motor was selected and placed on the back of the machine as far away as possible from the sound head. Conventional projectors have always used high-speed motors because they are cheaper and also because the higher speed gave them more air for cooling purposes, which was needed with large lamps. While high-speed motors are satisfactory from this standpoint, they are more noisy than slow-speed motors and a high-speed fan is rather noisy in operation. A slow-speed motor was selected, therefore, and a slow-speed fan to deliver a volume of air to cool lamps up to 750 watts, without noise from either the motor or the fan. In storing the projector, the reel arms are taken from the machine and placed in the lid of the case, which also contains the speaker and microphone, so that the whole unit fits into one case [see Fig. 4 in the preceding paper in this *Journal*]. The weight of the machine is approximately 35 lb.

The machine comes with a two-channel amplifier for recording purposes. It is possible, therefore, to record from a microphone and from another source of sound such as a turntable at the same time. The two signal sources can be mixed together so that there is background music or sound effects behind voice, and the level of the voice and the music are independently controlled. A headphone jack is provided so that the mix can be monitored at the time of recording. A separate mixer with several channels is available as an accessory.

The volume is indicated by a small neon lamp, Figure 3 [a large view of the control panel, not reprinted]. An erase head has been built into the record and playback head so that any old signal is automatically erased just before the new signal is recorded, when the amplifier is in record position. A mechanical safety lock is built into the control switch so that it is not possible to accidentally erase previously recorded sound.

In order to record sound-on-film, it is only necessary to place a magnetically striped film in the projector and put the control switch on record position, adjust the volume for recording, and proceed to record. After the recording is done, the film is rewound, it is rethreaded into the projector and projects a sound picture. If, for any reason, the recording is not satisfactory, a new recording can be immediately made and the old track will be erased as the new one is being recorded.

Compact Rear-Screen Projector for 8mm Films With Magnetic Sound Stripe

By R. G. HENNESSEY

There are properties of 8mm magnetic film which permit exceptional life as well as initial economy in adaptation. Equipment advantages in comparison to previously existing machines are presented. Results of life test runs are presented as well as results of other tests. Various applications of 8mm equipment are described in detail.

NEVER in history has the demand for improvement in transmission of ideas and techniques been so urgent. Whether the field be education, foreign affairs or merchandising, continual challenge is found in the search for stream-lined methods for communication of increasingly complex information. To date, no medium can approach the universal impact of the sound motion picture in gaining attention and ensuring acceptance. Regardless of age, sex or background, the understanding and retention of presented information far exceeds results obtained by any other pre-programmed method.

A new and perhaps revolutionary motion-picture tool is now coming of age in the development of 8mm magnetic sound film. Its flexibility and economy seem to offer a timely answer to the current need for modernized audio-visual systems. Introduced on the American scene slightly more than a year ago, it immediately resulted in activity which gave indication of its promise.

Film recorded with Cinephonic 8mm sound cameras (Fig. 1) has been accepted as evidence in Federal Court and cited in a formal decision as a predominant influence in making an award. An intriguing point is that 8mm size and simplicity permitted candid camera techniques in picture taking as well as ease in later courtroom use of the sound projector (Fig. 2).

Highway officials and public utility groups have used the same combination of equipment for on-the-spot coverage of accidents. In subsequent safety campaigns, spontaneous commentary by observers and participants were dramatic high spots in presentations of recorded mishaps.

High schools and charm schools, precision industries and amusement industries have found equally advantageous the permanent recording of activities on 8mm magnetic sound film. In some cases the aim is self-evaluation, in others, the transmission of the "first-hand" type of information to separated groups. In each situation, flexibility and economy have been primary factors in the decision to utilize this tool.

While this type of usage was significant and expanding, it was evident that the potential for almost universal application of 8mm magnetic films could not be fully realized until a viewing unit was designed specifically for audio-visual use.

Development has now been successfully concluded. Production engineered equipment can be presented. The program through which it evolved can now be reviewed.

Equipment Design Considerations

The design criteria set for this equipment aimed at significant reductions in size, weight, complexity and cost in comparison to any existing equipment. In mind was a tool to assist communication in teaching, training and selling. Specifically, the tool was to be a lightweight, rear-screen, 8mm sound projector. The basic criteria for it were:

(1) operational simplicity,

(2) minimize size, weight and cost, and

(3) maximum durability — life and handling.

In satisfying item 1, all associated components, such as speaker, screen and line cord, were to be self-contained. To permit repeated showings without rewind or rethreading, a continuous magazine was considered essential.

In regard to item 2, size on the order of a small portable typewriter and a target weight of 15 lb were felt to be satisfactory. Cost, even in single-unit quantity, it was felt, should be well under $400.

Item 3 made mandatory the development of a completely transistorized amplifier with an output of about 3 w and the design of a mechanism and film-

Presented on May 9, 1961, at the Society's Convention in Toronto by R. G. Hennessey, Industrial Products Div., Fairchild Camera & Instrument Corp., 580 Midland Ave., Yonkers, N. Y.

(This paper was received on April 4, 1961.)

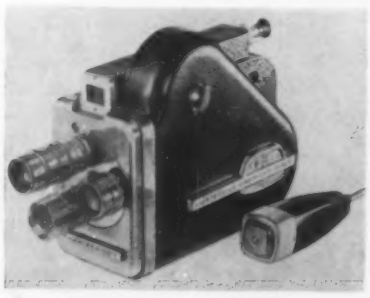


Fig. 1. Fairchild Cinephonic 8mm sound camera.

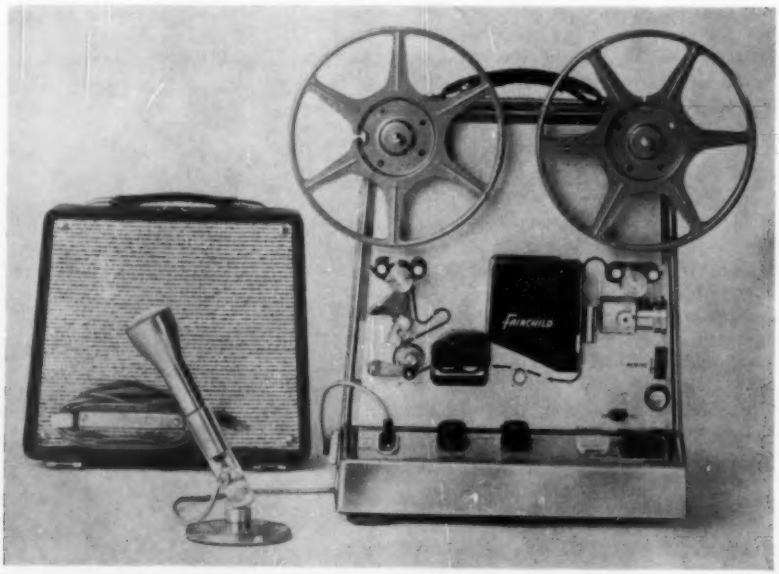


Fig. 2. Fairchild Cinephonic 8mm sound projector.

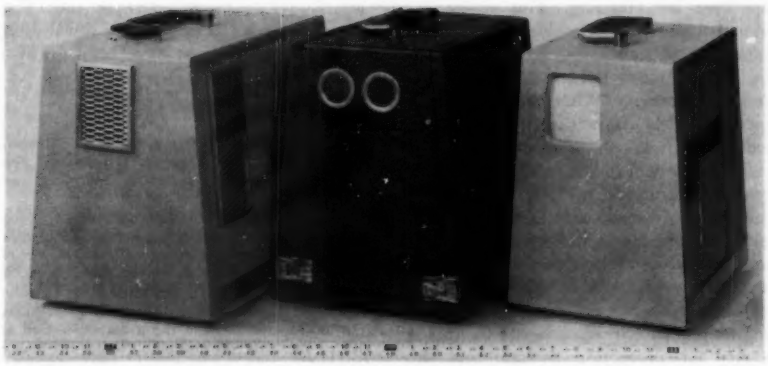


Fig. 3. Successive audio-visual projector prototypes.

Fig. 4. Final Fairchild Audio-Visual Projector.

path components to provide heavy-duty advantages without weight penalties.

In addition to advantages intended for the user, it was realized that audience consideration demanded a very low level of machine noise and good screen brightness.

Film Capabilities

Because we recognized that our "ultimate weapon" would be influenced in its successful application by the characteristics of its ammunition, our early investigation was searching and thorough in this direction. We were soon satisfied that the cost of 8mm reduction prints, magnetic striped and sound printed, would show a saving of 25 to 35% over 16mm. We also felt that an improvement in life would be likely.

A program of testing was begun using different types of 8mm films and magnetic stripes. Results indicated durability far in excess of anticipation. The linear speed of 8mm film is only half that of 16mm when projected at the same frame rate, and because of shorter pull-down and narrower width the acceleration stresses are greatly reduced. When the film is stored in a continuous loop coil, the area of surface contact is low and tension loads decrease correspondingly. Additionally, the narrower film has superior ability to resist perforation damage because of mishandling.

The conclusion, based on exhaustive tests under full operating conditions, was that 8mm sound-striped film is capable of repeated and continuous projection for well over 1000 showings. This of course assumes a path and claw design which eliminates small radii and unnecessarily high accelerations. Heat is also a factor to be kept within reasonable limits to avoid premature film aging and embrittlement.

The magnetic stripe, either dispersion or laminate, imposed no limitation on life, the fact being that it exceeded the emulsion in endurance. Indeed, it may be said to protect the emulsion, especially in the endless coil where it tends to prevent intimate surface contact. The raised stripe affords a bearing surface which reduces film pullout tension while supporting pressures normal to the film surfaces.

Projection Equipment

The line of equipment which resulted from our development program is unique and meets the criteria originally stated. Lightweight and self-contained, it is capable of continuous showing of magazine-loaded 8mm magnetic sound film in lengths up to 400 ft. This exceeds 20 min in single running time.

Figure 3 shows, left to right, successive prototypes of the equipment. The relative size can be judged by comparison and by reference to the scale included in the illustration. Weights ranged from 20 lb for the unit on the left to 15 lb for the final unit on the right. The maximum dimensions of the last unit are 12 in. high, 12 in. wide and $8\frac{3}{4}$ in. deep to contain the projector, amplifier, magazine, screen, speaker and controls.

Another view of this final model (Fig. 4) shows the side which provides the access door for loading and service.

In operating mode (Fig. 5), the side opposite the service door hinges to a horizontal position. A projection screen, equipped with side wings, folds down from the front edge of this horizontally locked door. Visible in the illustration is

Fig. 5. The projector in operating position.

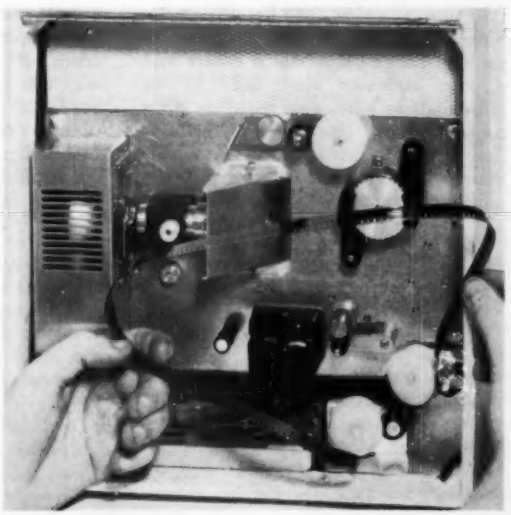


Fig. 6. Audio-visual mechanism and lamp side.

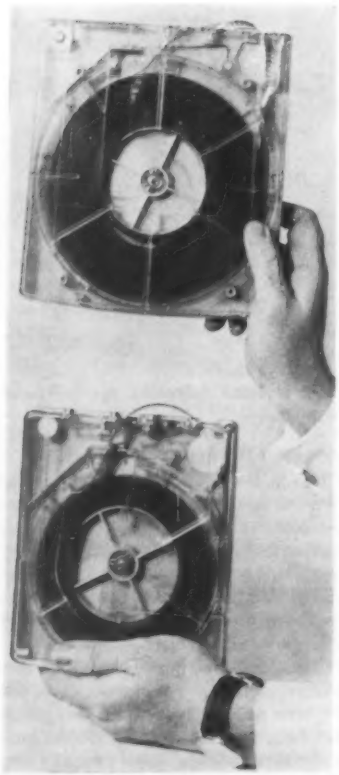


Fig. 7. The projector magazines, 200- and 400-ft capacity.

a control section, recessed at the body grille. Here a single knob provides on-off and volume control for the system. Additionally, a jack is provided for optional use of a headset or an external speaker. Symmetrically opposite on the grille and not shown in this illustration is an additional recess and a reel-up line cord for a-c supply.

Figure 6 shows the mechanism and lamp side of this same model with magazine in place and film loop withdrawn for threading. Several design points are evident in this view. The simple path assures minimum film wear and ease in loading. Large diameters in rollers and sprocket eliminate small radii in the film-handling path, thus reducing stress concentrations, especially at perforation corners in brittle films. The mirror housing (to right of lens) is a snap-out unit and permits easy access to lens and aperture for cleaning. This quick removal feature also provides for adaptation to straight front-screen projection by replacement with a two-mirror, snap-on accessory. When this is used, the picture throw is parallel with the lens axis, as with conventional projectors.

To permit continuous showing, or successive operations without having to rewind or rethread, modified tape magazines provide film exit from a center coil and take-up on the outside coil. Figure 7 shows both 200- and 400-ft capacity magazines. In storage, the loose threading loop is withdrawn into the magazine cavity for protection by spinning the magazine turntable with the loop free. When threading, this loop is again pulled out to the necessary length. No drive for these magazines is employed. Properly modified, the film tension on the feed side is quite low, and yet serves to rotate the turntable and stored coil so as to accomplish take-up.

Conclusion

The simplicity of the final design is its most apparent feature. This simple design took considerable effort and a much longer time than other more complicated designs, now discarded. The effort to avoid straying from the single-purpose machine was constant. Expanding functions invariably introduced complexity.

In the case of the amplifier, advantage was taken of special-purpose silicon transistors developed by Fairchild's Semi Conductor Div. for end uses far more demanding than in the audio-visual projector.

Weight and space problems were initially posed by transformers. In this final unit there is not a single transformer as such. Windings added to the motor iron provide all the a-c stepdown voltages needed and even the amplifier, though push-pull, requires no output transformer.

In reducing claw noise below the conventional minimum, advantage was taken of the unidirectional advance which is the only requirement in this particular machine.

In general, then, we have idealized this design by keeping its specific end use in mind in preference to modifying already existing equipment originally intended for general purpose use. The corresponding benefits in durability, weight, size and cost have been gratifying.

Discussion

Harry Sombor (*General Electric Co., Syracuse, N.Y.*): What sort of frequency response did you get in the combined system of recording and reproduction?

Mr. Hennessey: There is no difficulty in going out to 7000 cps, and there is no difficulty in obtaining a signal-to-noise ratio of 45 db. I should qualify that by saying "at 24." Sixteen, of course, is a mythical number these days; 18 is the figure. It will be somewhat less than 7000 cps, not too much I think. I ran a demonstration at 18 for the SMPTE group in New York and I think, by ear, it was quite good. The investigation that we do is a serious effort — it takes a lot of time. We speak in terms of 2000-hr life, which in 24-hr days requires some time to run tests. On the sound side all work has been at 24 because this is definitely the standard and the numbers I gave you were at 24 frames/sec.

Mr. Sombor: What sort of film stocks have been successfully prestriped?

Mr. Hennessey: We have simply gone to any number of labs and received a beautiful job on picture and sound as well, it being reduction from 16mm to 8mm, of course.

Gary Kaess (*Keystone Camera Co., Boston, Mass.*): What lamp were you using in your projector?

Mr. Hennessey: We are using, throughout the projector, wherever possible, low voltages. Now, this ties to the awareness that in the educational field, low voltages are a nice point. It is a low-voltage lamp, the amplifier is a low-voltage amplifier; there are no voltages that are exposed that are higher than in an electric train set.

Mr. Kaess: You're not using the same Sylvania you are using in your regular machine, are you?

Mr. Hennessey: Oh no.

Mr. Kaess: What's the life on the head? You say 500 hr on the total machine. What do you expect out of the heads themselves?

Mr. Hennessey: We'll certainly have to approach that with the head as well, and tests indicate that this is accomplishable.

George Lewin (*Army Pictorial Center, Long Island City, N.Y.*): With the large sprocket you mentioned, do you anticipate any problems with film after it has shrunk?

Mr. Hennessey: No. The number of teeth engaged on that sprocket is pretty conventional. We have a large sprocket mainly to avoid taking the film through radii or around radii that are small. We are trying to keep the path so that it's relatively gentle, so that the curvatures are large. It's not a matter of getting more teeth on the sprocket.

Mr. Lewin: Would you care to give us any estimate of the flutter that you achieve in this machine?

Mr. Hennessey: 1% peak to peak.

Fred Aufhauser (*Vicom, Inc., Rochester, N.Y.*): What size screen are you using?

Mr. Hennessey: It's nominally an $8\frac{1}{2} \times 11$, probably closer to $8\frac{1}{4} \times 10\frac{3}{4}$. Actually that screen size is pretty much what sets the package size.

An Educator Looks at 8mm Sound Film

By LOUIS FORSDALE

The development of 8mm sound film suggests important advances for film in education, including increased use resulting from decentralization of film libraries, increased use of film by small groups and individual learners, expanded lists of titles, new uses in research and exploitation of local production possibilities. Many of these advances are critically dependent, however, on the availability of vastly simpler, lighter and cheaper projectors and viewers, and on improvements in 8mm sound cameras.

At the moment 8mm sound motion pictures are almost unknown in education. Even audio-visual directors who make a point of being informed have had little opportunity to learn of the new medium. Before long, however, we are likely to recognize 8mm sound film as a significant advance in audio-visual education. If the economic problems can be resolved favorably, as I think they can be, 8mm sound film may help remake the uses of film in education so thoroughly that our present patterns will be mere memories in a generation. This rather optimistic estimate is not shared by all observers of the educational film field, of course. For that reason it needs examination.

What can 8mm sound film offer over 16mm film, the educational stand-by for twenty-five years? Two things: increased economy and increased convenience. On these two advantages new systems of film utilization can be postulated. The two factors of economy and convenience are closely interrelated, but the cost problem is likely to be uppermost in the thinking of those people in education who must make the decisions.

Print costs will be a critical matter in the success or failure of 8mm sound film in education, and it is quite clear that low print cost depends on a market much larger than the one we now have for educational films. Production costs of motion pictures will be no cheaper merely because the size in which they are eventually released is smaller. If, then, we continue to market our educational films in tiny quantities, where a total sale of 500 is considered respectable, the reduced cost of film stock is not going to be a very important factor in lowering sale prices significantly. But if interest in 8mm films is created by somewhat reduced costs, and particularly by radical new approaches to projection equipment, we should see emerging, slowly, an expanded market which could take advantage of the quantity printing processes that are being developed in the laboratories, the unit cost of processing and selling film would be reduced, and a favorable downward price spiral would have been started. It is quite apparent that if print sales numbered in the thousands rather than the hundreds prices of release prints would be lowered dramatically.

What could happen in education, given reduced costs of prints? A very important thing: educational film libraries might decentralize, moving prints closer to the point of utilization, thus making them more accessible to teachers and students at the right moment. Today most of the schools in the United States do not have films located permanently in their own buildings. Films are either rented from nearby film centers, or they are held in central audio-visual libraries which are maintained by the community. The teacher who wants to use a film, then, must plan well in advance; a request must be processed; the film has to be delivered and returned; and the film must be used when it arrives, whether that is actually the most opportune time or not. It is seldom available for a second showing later and almost never is the student able to study it alone outside of the group showing. This is a troublesome, inefficient and expensive process, and it undoubtedly cuts down on effective film utilization.

Given cheaper print costs (and the reduced storage problem implied in 8mm sound film), communities would be tempted to begin decentralizing their libraries, putting at least the most frequently used prints in individual schools. Some schools could afford to take decentralization a step further and deposit certain films in school departments, or even in individual classrooms. Is it a dream to imagine that one day every school library will have hundreds, even thousands of motion pictures accessible to its teachers and students?

As I shall note later, the likelihood of saturating a school system with films would be materially increased if we had profound advances in projector design such that teachers and students could use films at a moment's notice with a minimum of difficulty and timidity.

Quality

However inexpensive 8mm sound motion pictures might be, we dare not think of moving from 16mm to 8mm if sound quality and picture quality of the latter are not good, and this is a matter which deeply concerns many educators. Indeed, if the cost of prints and equipment is low enough, the only serious question which can be raised about 8mm sound film in the long run is: How good is it?

The quality problem is a difficult one to assess because it involves so many subjective judgments, so many assumptions based on prior experience, and because we are in such an early stage of the art.

After extensive study, judging subjectively, my colleagues and I conclude that when the magnetic soundtracks are properly handled their adequacy for most educational purposes is beyond question. They are not always properly handled, of course, but this is no fault of the medium. I assume, too, that if a switch were made to photographic tracks, the loss, if any, would not be excessive or a shift would not be countenanced by the industry.

The picture presents a more difficult quality problem. I have seen many hundreds of feet of 8mm sound film, both commercially available titles and our own locally produced footage. Picture quality varies widely. The best prints I have seen — perhaps ones which were given kid glove treatment in the laboratories — were almost universally received by audiences of teachers as being "as good as 16mm," when shown off a four-foot screen under optimum viewing conditions. Too frequently, however, my colleagues and I find ourselves fiddling with the projector lens in a futile effort to improve focus, and we nearly always yearn for more light than there is on the screen. I assume that engineers are quite aware of these problems, however, and that improved emulsions, printing processes, screens, projection light sources and lenses will soon alleviate the problem.

Projector Design

A much more critical problem is that of projector design, for this is at the heart of the convenience problem. Educational film, whether in 16mm or 8mm, will never achieve its potential until we have inexpensive and simply operated projectors. For the average teacher, a motion-picture projector is a formidable instrument. To use it involves special

Presented on May 9, 1961, at the Society's Convention in Toronto by Louis Forsdale, Horace Mann-Lincoln Institute of School Experimentation, Teachers College, Columbia University, 525 West 120 St., New York 27.
(This paper was received on April 3, 1961.)

training, and loss of facility apparently occurs very rapidly. Many schools have crews of student projectionists, but this is, at best, an awkard way to handle the problem because it involves too much preplanning, too much confusion, and, incidentally, too much lost time for those students who operate the machines.

We should work toward projection systems which will permit everybody in the educational enterprise to use film, including a six-year-old child. This is an important point because one of the most productive directions in which film utilization can go is toward the use of film by individual students, even first graders, as they now use books. There is nothing inherent in film which makes it a group medium except cost of prints and projectors and complexity of projection equipment.

I have talked enough with engineers to believe that the challenge of manufacturing vastly simplified, inexpensive film viewing equipment can be met if there is a market to support the effort, and 8mm sound film should bring with it a market large enough to encourage many new approaches to projector design. The educational market alone probably will not be large for some time, but a vast amateur and business market looks probable, and we educators will be glad to use equipment which has been made possible by other markets.

I believe that the optimum solution is a true cartridge-loading projector, but if the cost and technical problems inherent in that approach are insurmountable, we should at least have foolproof self-threading or slot-loading equipment, hopefully at prices equal to or below those of classroom tape recorders.

Whatever the design solution might be, there are three results which clearly could flow from foolproof, inexpensive projection equipment. First, and perhaps most important in terms of educational theory, students themselves could use film as a learning resource, freeing film for the first time from the tyranny of group viewing. One can envision small, cartridge-loading, rear-screen projectors located for student use in classrooms, libraries and homes. Second, teachers undoubtedly would use motion pictures more frequently, and to better advantage, with regular class groups. Third, an opportunity would be opened for developing a new kind of educational film — a short film which makes one or two points with a minimum of introduction and exposition. Such materials would be an important asset in education, but they are impractical at the moment — it would take more than the showing time of such a film to set up projector and screen and thread the film.

Local Production

In the years ahead teachers and students will probably make many more films locally because of the low cost of 8mm film and the relative simplicity of operation and low cost of 8mm cameras. Our study at Teachers College suggests that these subprofessional films might be of several kinds. *Skill* films would be useful to show students (who might study them repeatedly on simple projectors) how to operate a lathe, a sewing machine, a pottery kiln and the like. Films to record and permit study of *performance* could give students a chance to see themselves in action as athletes, student teachers, actors, psychological counselors-in-training, etc. Simple short *concept* films might be made to illuminate ideas from all areas of the curriculum.

Research uses of locally produced 8mm sound film, particularly at the college level, are promising. There are many problems in the physical and behaviorial sciences, for example, which cannot be studied adequately as they pass by. A psychologist who is studying, say, nonverbal communication, would find invaluable a film record which he could analyze repeatedly. Probably 8mm sound films will bring about an increase in the use of film as a *creative medium*, with students making films for the same reasons that they are given opportunities to write, paint, create music or participate in dramatics. It is likely that 8mm sound will be used increasingly in *planning for 16mm film production.* Errors in conception and execution can be discovered inexpensively on 8mm before committing oneself to 16mm or 35mm. Finally, *records* of events, visiting speakers, demonstrations, and so forth, can be kept fairly economically on 8mm sound film.

Camera Design

Local production depends in considerable measure on the kinds of cameras which are available. Fortunately, because of the huge amateur market, there are a great many silent cameras to choose from. At the moment, however, Fairchild offers the only 8mm sound-on-film camera; clearly, different types of cameras are needed.

It is apparent even at this early stage that we need 8mm sound-on-film cameras with huge film capacity for making uninterrupted records, and for research purposes. For our local purposes at Teachers College we are attempting to rig a 400-ft Mitchell external magazine on a Fairchild Cinephonic 8mm sound camera to get the extended time which many of our research people want. So far we have been unsuccessful, but even if it worked, this solution would obviously be an expedient one at best.

When Will 8mm Sound Be Important in Education?

Education is essentially a conservative institution. It is also comparatively poor, with some notable exceptions. For these reasons, I suspect it will take longer for 8mm sound to become important in education than it will in business and industry, and, perhaps, in the home. Quite aside from our present general state of ignorance about the implications of 8mm sound for education, our economic commitment to 16mm is great. Many schools are probably going to choose to wear out 16mm equipment and 16mm prints before they think about moving to 8mm. This is not true, of course, in those educational settings where there is no present commitment to 16mm — overseas in some of the "emerging" nations, for example. There, 8mm sound might be adopted very rapidly.

Even in the domestic market the use of 8mm sound could grow very rapidly if we thought of it as a top-to-bottom new opportunity for the educational film field rather than as the poor man's 16mm film. For the truth is that we are not dealing with a second-rate medium newly released from the clutches of enthusiastic but uncritical amateurs. The occasion of 8mm sound film gives us all the opportunity to think boldly about educational film in all its aspects — production, marketing, distribution, utilization. At the center of this delightful challenge is the motion-picture engineer, who, as in all significant advances in communication technology, must provide the crucial instruments. Before the time of Gutenberg the book was frequently chained to the monastery reading table, a tool to which the favored few had access. If film is more accessible today than the manuscript was, it is still chained to awkward distribution systems, and to complex projectors which only the few can own and operate.

There is no movement in American educational communication which holds greater promise than does 8mm sound film. We should work vigorously to bring that promise to reality as quickly as possible.

Discussion

George Lewin (Army Pictorial Center, Long Island City 1, N.Y.): It is pertinent to comment that now that we're evidently elevating 8mm to the standards of the SMPTE there is need for caution. We know that with 8mm we get away with many things, simply because we make the pictures smaller or use little background projection screens, so inherent defects are not noticed. It's not so easy to conceal the sound defects, because while it's true you don't need the high power output or you don't need the wide frequency response, there is one element in sound that just can't be concealed: the flutter content. The flutter has to be just as good on an 8mm projector as it is on a 35mm projector, especially if it is playing back music. This is something all the designers have to keep in mind.

Dr. Forsdale: I cannot respond at a technical level, but my subjective evaluation is that the soundtracks we have heard on 8mm — including ones with music — seemed quite adequate. I have not heard Mr. Maurer's photographic technique so I'm talking only about magnetic striping.

Anon: Returning to Mr. Lewin's comments: Recent browsing through a music course open for

high-school pupils in the Syracuse area, revealed excellent recorded sound but the reproduction equipment was wanting; and this was quarter-inch tape. So the comment does not wholly apply because there are good tape recorders and bad ones. And mind you the quality I heard out of these Eastman projectors was quite on a par with what I heard on those quarter-inch tape recorders in reproduction.

John A. Maurer (JM Developments, Inc., New York): Dr. Forsdale spoke of the need for low cost in film. Now the basic cost of film is the film itself. If we apply the maximum of ingenuity we can make the cost of printing and processing the film approach zero, but we cannot do away with the film itself. The question is, in the event that we could get the cost of 8mm sound film down to a quarter of the present 16mm cost, this being the ratio of the amounts of film stock consumed, would that be sufficient to free films for the uses that you have in mind in the schools — or ought we start thinking about something even more radical, say new methods of image duplication and new kinds of film?

Dr. Forsdale: My feeling is that if we were able to get 8mm down to one quarter the price of 16mm release prints of today, this would make a very big difference; but if we could drive the cost down to one tenth, that would very dramatically affect the whole film utilization problem.

Maxwell A. Kerr (Perkin-Elmer Corp., Norwalk, Conn.): In the education process there's frequent need for reference to a single frame for an indefinite time. Teaching machines and textbooks follow this principle. I am evolving different devices and need to see a proper relation between the need for still picture reference related to sound motion pictures.

Dr. Forsdale: Reference to a still picture is very desirable and the film strip has that advantage; however, if 8mm sound film does go down markedly in price then we could run the footage through for a sufficiently long time so that we have, in effect, a still picture on the screen for 30 sec or so, although not con rolled by the viewer, it's true. Secondly, there are many means of cuing motion-picture films to stop on demand for single-frame viewing.

Comment by mail — Mr. Kerr: It would be of decided help if Dr. Forsdale and others in educational pyschology would provide the motion-picture industry with some figures on the relative merit and time duration of classroom use of still pictures with accompanying sound as compared to sound motion pictures. If a major part of teaching needs can be handled by still pictures and closely related sound without the need for showing motion, then a sound filmstrip would be cheaper and more compact than the lowest cost 8mm sound picture. The sound filmstrip also offers more flexibility in the hands of the teacher since any picture can be held longer for pupil-teacher discussion and study.

As an example of size and cost reduction, I am developing a sound filmstrip (pictures and sound on the same filmstrip) which can reduce a 400 ft 16mm sound motion picture to a sound filmstrip a little over 11 ft long, and which can use the original soundtrack with little alteration. Estimated cost, in color, would be between $3.00 and $5.00. The usefulness of such a system of still pictures and closely related sound depends on the principle that the major need of the teaching situation can be met with still pictures instead of requiring motion pictures; and that it is more important to allow interruptions and discussions at frequent points during the film than to require continuous projection as in the case of motion pictures.

Can educators provide equipment developers with any figures on the relative merit of moving pictures with sound as compared to a series of still pictures with sound?

Dr. Forsdale: It is apparent that many educational jobs can be handled easily with a series of still pictures, and the mushrooming popularity of the filmstrip shows that teachers like the medium. On the other hand, it seems clear that certain problems require handling in motion, especially where motion is inherent in the subject matter. How the addition of motion helps or hinders where it is not inherent in the subject I cannot say at the moment, although studies have been made of the problem. It is true that we should look more deeply into these questions.

I have seen, heard and been impressed by the sound-on-filmstrip development The Kalart Company is demonstrating, to which your system seems to bear at least some resemblence. It should be an important contribution.

8mm and the Classroom Film Library: Potentials and Requirements

By STEVE KNUDSEN

Our present pattern of educational use of film involves film rentals, special projection rooms and passed-around projectors. Can 8mm serve as the agent to change this to a pattern in which an adequate library of films and the necessary projection facilities remain in, and are an integral part of, the classroom? If so, what will be the scope of such a shift? What are the requirements before such a shift can take place?

MANY EDUCATORS, including both teachers and administrators, look forward to the classroom film library as a simple and straight-forward answer to many of the ills now besetting the use of film in education. The prevailing pattern is based on a rental system which requires weeks and months of advance scheduling and includes the possibility of substituted titles, the moving of students to remote projection rooms and a system of passed-around projectors. Teachers would like to equip each classroom with its own projector in a ready-to-go status and with its own film library so the needed titles could be available at the precise teachable moment.

Can 8mm be the agent for changing from the rental system to a pattern built around the classroom film library?

Presented on May 9, 1961, at the Society's Convention in Toronto by Steve Knudsen, Film Production Unit, Iowa State University, Ames, Iowa.
(This paper was received on April 1, 1961.)

Acceptability of Technical Quality

There are many papers devoted to the aspects of 8mm sound film quality and its improvement. Two points not often included are pertinent here:

The capabilities of 8mm are related to audience size. The average elementary class in the United States today has 29.5 pupils; high-school classes are smaller. The rapidly growing school population and significant school district reorganizations into larger units are influences toward larger classes; countering this trend is a very prevalent feeling among the teachers that in a typical situation anything over 30 pupils per class approaches overloading.

The second pertinent consideration is the space for film storage within a classroom, which has to have blackboards and bulletin boards and natural light through windows, all requiring wall space. A wall cabinet to store an 8mm classroom film library needs a space no larger than 4 by 5 ft.

Scope and Economics

Suppose an elementary teacher had, right in her classroom, all the films which might be pertinent to her material. How many minutes of each day would that elementary teacher use in projection? The assumption is made here that the total time used per day would be a half hour. For convenience, we may divide the 30 minutes into three 10-minute periods, meaning for practical purposes three reels per day. The U.S. Office of Education gives a figure of 861,035 elementary teachers for the fall of 1960. Using a figure of 860,000 classrooms, each requiring 3 reels per day, gives us a daily requirement of 2,580,000 reels for the entire nation.

Similarly, we might anticipate the demand for secondary education — again assuming a classroom film library. A typical schedule for secondary pupils involves four subjects. Round off the number of secondary teachers to 549,000 (U.S. Office of Education figure, 548,-960) and assume that each teacher in each subject will use one 10-minute reel per day. However, the actual requirement will be less since a secondary teacher may have more than one class in History I or Algebra II or some other subject. To allow for this, a figure of 2.5 ten-minute reels per day is used here.

This gives a total of 1,372,500 reels per day for use in the secondary schools of the entire nation.

The figures for both elementary and secondary classrooms total 3,952,500, or just short of 4 million reels per day. There are 180 days in the school year. The product is a staggering total of 720 million reels per year. This roughly would be the requirement for classroom film libraries in our public schools across the nation.

Using $120 as the current price for a 10-minute 16mm reel in color and sound and assuming that each film will need replacement in six years, we find that the cost per year per reel would be $20. Hence the total yearly cost at present 16mm prices would be $20 times 720 million or $14,400,000,000 for the nation.

Dividing this 14-plus billion dollars by the number of classrooms in the United States would give us a figure for each classroom of $10,220, which would be almost enough to triple the number of teachers that we now have. It should be obvious to teachers and educators, who have long been asking for classroom film libraries, why, under out present system, such libraries are impractical.

Would economies resulting from the use of 8mm film be sufficient to make the classroom film library feasible?

The three major components of the final cost of a film are the cost of the print, the cost allocated to each print to amortize distribution, and the costs of merchandising. The relative importance under today's practices are (approximately):

	Cost	*Per Cent*
16mm Print, per reel...	$ 24	20
Amortization of Production and Merchandising	96	80
Total	$120	100

The costs for amortization and costs for merchandising appear to vary widely among distributors. Actually there is no point in disputing just what the proper figures for each might be. The total is known and the two combined do constitute a major share of the final price paid by the customer, our public schools.

What happens in 8mm? On the item of print costs, the laboratories are quoting figures varying between one-third and one-half of the present 16mm print costs. The lower figure is being used here for reasons which will be apparent later. Assume (optimistically) that other costs would continue their present ratios, then:

	Cost	*Per Cent*
8mm Print, per reel.....	$ 8	20
Amoritization and Merchandising	32	80
Total	$40	100

To supply classroom film libraries over the entire nation at the $40 figure would still be the equivalent, costwise, of adding six new teachers for every ten we now have. The cost is still too high for "every-classroom" adoption although significantly lower for specialized situations.

What happens if we achieve *mass production* of 8mm prints? To approximate some end points of what might be a snowballing process will be easier than to trace a pattern of price reductions.

The estimate for an end point in print costs is based on a ratio between finished-print and raw-stock costs. The $24 cost of a one-reel color positive print in 16mm is approximately three times the cost of the raw stock (about 0.06 cents/ft finished compared with about 0.02 cents/ft raw). Our laboratories are working on about a 3:1 ratio. As an end point under mass production in 8mm, let us assume this is improved to a 2:1 ratio. This would make the print cost for a single 8mm reel $4.00.

The amortization costs can be more drastically reduced than the other major costs. Savings will be possible if significant increases in production volume bring increased efficiency. But more significantly, the amortization can be based on a much greater anticipated demand. It should be possible for this figure to go as low as $1.00 per reel.

The estimate of an end point in merchandising costs is based on information from the related field of textbook publication. In that field a rule of thumb gives a selling price of 2.5 times the manufacturing price. Based on these estimates, the figures would be as follows:

8mm Print cost in mass production	$ 4.00
Amortization.....	1.00
	5.00
Merchandising.....	× 2½
Total	$12.50

Even with a total figure of $12.50 per single reel, the cost per classroom would amount to $1,125 per year for elementary grades and to $937.50 for secondary grades. However, all the above figures are based on the use of sound color prints. The use of black-and-white as well as the use of silent films could materially reduce these figures.

The Process of Adoption

However, cost alone will not ensure that 8mm film will serve to change our pattern of the use of educational film. There are other factors to consider.

George Beal and Joe Bohlen* have summarized the findings of 35 research studies and have constructed frameworks useful in studying the problems of diffusing new ideas and practices. One of these frameworks is concerned with the relative complexity of an anticipated change and four categories are named: (1) a change in materials and equipment, (2) an improved practice, (3) an innovation and (4) a change in enterprise.

A straightforward change to 8mm where 16mm is now used would be a simple change in materials and equipment; but a change from film rentals to a classroom library would rank as an innovation. The summary mentioned above describes an innovation as "... a change which involves not only a change in materials, but also a complex of changes with regard to their use."

Changing to a classroom film library pattern will mean that the film will no longer be regarded as something which must be projected during class time. Home viewing, the use of film viewers in library cubicles and the application of 8mm films in teaching machines will almost certainly come into use. These uses will enable the film to contribute to what teachers call "outside preparation."

Using film for outside preparation will in turn affect those films which are reserved for showing during class time periods. Use of the long, comprehensive film will probably diminish inside the classroom; but there will be increasing use of the short, single-concept film, the problem or situtation film and the summary film.

The single-concept film will be very short — perhaps 3 min long; it will deal with a single major point. It may be animation visualizing the deflection of alpha and beta particles by a magnet; it may be photomicrography of a biological form function; or it may be a time-lapse record of an experiment which can thus be reduced from hours to seconds. Very short films of this type are not being distributed today because of the economics involved.

When a film is used to set a problem or pose a situation, it can add a new dimension to that problem. Not only is the student required to take the data given and to make computations, but he can be required to make the observations as well.

The summary film will continue to be effective during class time because of its ability to confine the class to the topic, because the graphic information assists in the recall and because distractions by questions from the class are eliminated.

The danger in the process of adoption in this situation is that the lay teacher will identify 8mm as a change in materials only and will fail to see the possibilities and the implications of its potential to bring about a classroom library. Furthermore, even if the teacher recognizes the possibilities, evaluation will be very difficult because so few films of the proper type exist. From a more positive point of view, the production of films designed specifically for the classroom library will

* George M. Beal and Joe M. Bohlen, "The Diffusion Process," Special Report #8, Agricultural Extension Service, Iowa State Univ., Ames, Iowa.

in turn provide some impetus to this snowballing effect.

Summary

A pattern of utilization of educational film based on a classroom film library is much more feasible with 8mm than with 16mm. But 8mm does not guarantee, in and of itself, that a classroom film library pattern will develop. There are collateral requirements which must be met — requirements in terms of film design and of making the educators aware of the possibilities. Organized effort is needed and can do much at this stage of development.

A Self-Contained Recorder for Motion-Picture Sound

By WILLIAM V. STANCIL

New techniques in motion-picture production now require compact camera and sound equipment. A self-contained, battery-operated and transistorized tape recorder is described which provides synchronization with both spring-driven and motor-driven cameras. The 13-lb recorder may be used in conjunction with 35mm, 16mm or 8mm cameras, and the resultant sound may be transferred to sprocketed film for editing and subsequent release, or it may be synchronized with projectors for double-system viewing.

WHEN SOUND was originally introduced to motion pictures, it created tremendous interest, and the public accepted the relatively static performances. Through the intervening years, both the producers and directors have sought more compact equipment to free them from fixed locations and confined areas. While the cameras have remained approximately the same size, new acoustical housings are available which greatly reduce their bulkiness. The sound equipment has made tremendous strides in departing from the original telephone company concept of centralized transmission racks down to hand-carried, self-contained units.

The volume of program material demanded for television has somewhat reduced the production standards that motion pictures have always tried to achieve. The sheer bulk of television productions precluded the many dramatic techniques and the excellent quality which motion-picture people had come to expect. Since now more people see television than ever before witnessed theater motion pictures, perhaps the public's viewing standards are somewhat lower. With this transition of both techniques and standards has come the increased demand for mobility involving the documentary type of dramatic presentations.

A number of evolutions had to transpire to permit a fluid type of motion-picture production, whether it be for theater or television release. The feeling has always been that since 35mm cameras were large and heavy, there was little incentive to reduce the motor-drive systems and power supplies. Hence, with heavy and large camera equipment, not too much concern was felt about the size and efficiency of the accompanying sound equipment. All the technicians associated in the editing and processing of both the sound and pictures felt no urgency to depart from their recognized procedures. With the excellent progress made in Europe in the tape-recording field, some of the motion-picture studios worked out methods of synchronizing nonsprocketed tape with standard motion-picture film. Outgrowths of this work appeared in the United States in the form of a 60-cycle signal recorded transversely in the center of $\frac{1}{4}$-in. tape. The 60 cycles which was recorded was the same as used to drive the synchronous motor on the camera so that on reproduction the 60 cycles was "resolved" and used to control the transfer from tape to magnetic film. Through the years this system has proved very satisfactory, and in the United States and in Canada a number of motion pictures have been and are being produced by this system. Other systems were subsequently employed in the United States wherein a carrier frequency recorded on the same track with the normal audiofrequency was modulated by 60 cycles, and again this signal was used for subsequent transfer. Two of the well-known magnetic recorder manufacturers in the United States employ this system.

These several systems did prove that synchronized tape could be successfully handled with the sprocket hole film. Perhaps the approach of directly recording 60 cycles has proved slightly more satisfactory because of the ease in recording and reproducing 60 cycles. High-frequency carrier signals have often been subject to dropouts and other interferences resulting from poor tape contact or foreign material which ultimately accumulated on the tape surface.

Experience With Miniature Tubes

The flexibility and broad requirements of the electronic systems in motion-picture recorders held back any major reduction in size until the advent of transistors. The Stancil-Hoffman Corp. of Hollywood, Calif., introduced the self-contained Minitape in 1949, and it was its intention to furnish a synchronized soundtrack for motion-picture production. The original recorder used miniature vacuum tubes with a preset recording level. A small d-c motor was speed-regulated by a tuned vibrator to realize high efficiency. It was planned to record two tracks on $\frac{1}{4}$-in. tape using one track for the audio and the second track for a synchronized signal. The state of the art at that time indicated a carrier frequency lower than had been used and yet modulated by 60 cycles. A frequency of 3000 cycles was chosen as this represented the maximum unequalized tape output. The program was not particularly stressed as either microphone mixing facilities had to be provided or automatic volume control incorporated as a means of holding the proper recording level. Extensive work was performed on subminiature tubes, but the inherent noise and "microphonics" of these tubes in high-gain audio circuits proved very discouraging. The corporation established the requirement and program for both a better mechanical system and improved electronics. Fortunately, at this time information was released on the new world of transistors. Projects were then established to design audio circuits with automatic-gain controls for miniature packaging. As a result, Stancil-Hoffman announced, and had in production, one of the first completely transistorized magnetic recorders available.

Presented on May 9, 1961, at the Society's Convention in Toronto by M. M. Elliott for the author, William V. Stancil, Stancil-Hoffman Corp., 921 N. Highland Ave., Hollywood 38.
(This paper was received on June 26, 1961.)

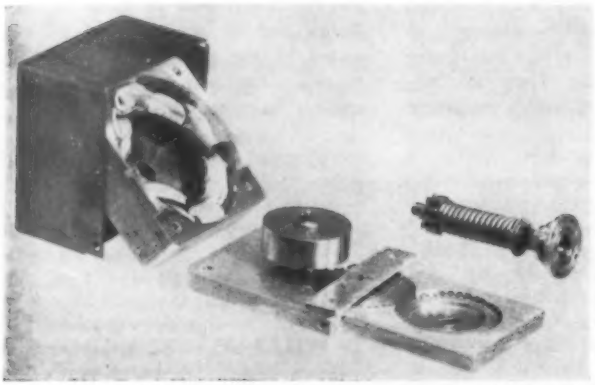


Fig. 1. Disassembled view of 4-pole sync generator, which, when spring-driven at 1800 rpm by a camera, will produce a 60-cycle synchronizing tone which is recorded on the 2-track battery-operated recorder.

Fig. 2. The 2-track battery-operated recorder with microphone and cable connection along with the cable connection to the spring-driven camera on which a 60-cycle synchronizing generator is installed.

Storage Battery Design

With the improved electronics, a new tape transport was designed and a stable and highly efficient, regulated d-c motor was developed. The new model seemed to provide all the facilities for dependable sound recording and the program was then centered on locating a suitable battery. The earlier Minitape had used lead acid storage batteries with fair success. When a unit is self-contained and offers such extreme portability, it is obviously used in the cruelest of environmental conditions. In the extreme low temperature ranges, the lead acid battery loses a large percentage of its capacity. Furthermore, miniature versions of these batteries require continuous maintenance, which, when coupled with their extremely poor regulation, basically eliminated such a battery for the new recorder. Other batteries had been introduced and extensive tests were made to locate a type of battery which would perform satisfactorily over the extreme temperature ranges and under all the conditions that would be encountered. As an outgrowth of the tests, the nickel-cadmium type of battery was chosen, as it presented excellent regulation and met the temperature requirements. Of importance, too, it was the least expensive of the newer battery designs that were available.

Battery manufacturers were encouraged to produce cells in the 4-amp-hr size. The first battery chosen for the Minitape seemed to offer this capacity and meet the other requirements, although it was a vented battery of the nonspillable type. Production problems in the manufacture of the battery apparently were not solved because many cells exhibited leaks in the plastic seal molding process. A limited number of recorders were released before the leakage tendency became apparent. Fortunately, a leading manufacturer in the United States completed the design of a sealed cell which is now incorporated in the recorder.

The Minitape was now complete. It offered excellent speed regulation, was of rugged and lightweight construction, and used transistorized amplifiers matching all professional standards of recording and reproducing. Stancil-Hoffman then re-established its program of synchronizing tape and film. It was decided that rather than use the 3000-cycle carrier, 60 cycles would be directly recorded on a second track. Since by this time most studios were equipped with two-track stereo equipment, the Minitape sound could be transferred conveniently in most areas.

Two tracks slightly over 90 mils each are recorded on $\frac{1}{4}$-in. tape. The audio track conforms to the practices of present magnetic standards. The 60 cycles is recorded on the second track, and while bias is not necessary it may or may not be used. If line power is available when a picture is being produced, the camera is equipped with a synchronous motor and a small portion of the signal from this 60-cycle source is recorded on the second track of the Minitape. For location shooting, the camera may be driven from rotary converters or other a-c sources so that again this same frequency is recorded.

The major attractiveness of the system, however, is its use away from power lines. The cameras are equipped with a subminiature 60-cycle generator so that they may be driven from either d-c or wild motors at a standard 24-frame/sec speed, and the generator produces 60 cycles. Some cameras lend themselves very well for the simple addition of the generator, whereas others have to be disassembled and gears installed to provide an 1800-rpm output shaft. The Eastman Kodak K-100 16mm motion-picture camera, for example, is one which requires little modification. Cameras such as the Arriflex 16 must be disassembled and a 10 : 1 gear ratio installed from a 180-rpm internal shaft.

The generator consists of a cylindrical permanent magnet rotating at 1800 rpm within a four-pole field coil structure. Depending upon the inductance of the recording head, the generator output is relatively low. In the case of the two-track Stancil-Hoffman heads, only 0.065 volt is needed for the 60-cycle track.

Adaptation of 8mm Camera

While an 8mm camera would not normally be used for commercial production, the corporation adapted an Eastman Kodak model which had automatic exposure and a zoomar lens. The combination of the Minitape with its automatic volume control and push-button operation, coupled with a camera having fixed focus and automatic exposure, created a "lip sync" motion-picture system for operation anywhere. The camera is small enough to be conveniently carried in one's pocket, and the recorder is easily carried by hand.

Fast color films have sufficient latitude to produce reasonably good quality pictures in night clubs and locations generally not suitable for normal equipment.

The 8mm camera is a production item which would not be suitable for the usual generator attachment. It was disassembled and a pinion gear was installed to be driven from the shutter drive. A shaft from this gear was extended through the mechanism to the rear of the camera where the generator was attached. A small two-wire cable electrically connected the generator to plug into the recorder. Some very interesting and unusual recordings were made on cable cars in San Francisco, on fire engines and horse-driven buggies in Disneyland, at several public indoor meetings. No attention was paid to either lighting or microphone placement, but the results were amazingly adequate for this type of "documentary" coverage.

The zoom-type lens was generally utilized for dramatic interest, and the automatic exposure followed exceedingly well from sunlight to reflected lighting in shadowed areas. In night clubs and auditoriums there was usually sufficient illumination from a spotlight or other stage lighting for reasonable quality. In some instances, the sound was picked up acoustically from the PA system, and in other instances, a direct pickup was made by attaching the microphone to some nearby prop.

The tests indicated the tremendous possibilities of 8mm sound color pictures produced by automatic and inexpensive equipment which certainly would satisfy all requirements for TV newsreel coverage. Some TV stations in the United States have adapted their film chains to accept 8mm projection. Many film-processing laboratories have recognized the challenge of fast film processing vs. video tape. Certainly in its favor is the fact that standard cameras of compact design can be universally used, and the final edited material can be projected throughout the world upon receipt.

Procedures for 16mm Applications

For most commercial applications it is felt that 16mm cameras would be used with the installed generator. On playback, the selected "takes" are rerecorded to sprocketed magnetic film for editing and transfer. The tapes recorded on the Minitape may be reproduced from it or from any standard stereo playback. The audio is fed to the magnetic film recorder and the 60-cycle tone is amplified through an 80-w amplifier to drive the synchronous motor on the film recorder. Obviously, any speed excursion in the camera or the recorder will compensate the speed of the synchronous motor when re-recording so that the time relationship between the picture and sound is always constant.

Any spring-driven camera will indicate a slight speed change as the spring runs down. This will affect the pitch of the recording, but generally on speech this would not be noticeable. Since the time capacity, as a function of the spring power is relatively short, scenes are covered in two or three angles and focal lengths. These are intercut to achieve the most interesting presentations, and the short "takes" do not hamper the end result.

For double-system viewing, a synchronous motor can be outboarded to any of the standard projectors. In this case, the Minitape sound is amplified to drive a loudspeaker, and the 60-cycle tone drives the projector synchronous motor through the separate power amplifier.

A number of methods can be used to establish the sync mark at the beginning of each scene. One method is to use a magnetic clutch to couple the synchronous motor to the projector. The motion-picture film is edited to select the desired scenes, and the clapstick or start mark is retained. The tape is similarily cut for the selected scenes, and a 3000-cycle tone, or other high-frequency tone, is superimposed at the point of the clapstick. In the experimental work accomplished at Stancil-Hoffman, a long strip of 3000 cycles was pre-recorded and ½-in. lengths were affixed over the clapstick modulation. When playing the tape back, the tone energized the magnetic clutch. By having the projector threaded to the start mark with the synchronous motor running, it instantaneously started when the magnetic clutch was energized.

Another method employed was to utilize a loop of tape between the reproduce head and a separate head which picked up the synchronizing signal. By varying the length of this loop, the synchronizing signal could be advanced or retarded to bring a scene in sync. Others have made the sync pickup head placement adjustable so that the distance between the sync signal and audio signal could be changed for retarding or advancing the synchronization.

The Minitape original sound quality will generally satisfy all production sound requirements for 35mm entertainment pictures, as well as the documentary and news coverage. This now provides the directors and producers with a flexible tool for production coverage that cannot be duplicated on the set. Television can greatly benefit by the simplicity and flexibility of the Minitape and compact cameras. While the process is probably too cumbersome for normal amateur shooting, film coverage of trips and expeditions can certainly be enhanced with the addition of sync sound to cover native music, background sounds and sound effects.

We are indebted to John Flory of Eastman Kodak for his encouragement and assistance in the 8mm phases of the sound synchronization.

High-Speed Inspection of Magnetic-Striped Release Prints

By BEN KLEINERMAN

A low-frequency (30-cycle) sine wave is recorded along with the audio when making the release print. This signal may then be picked up during high-speed (400 ft/min) examination of other physical defects. Thyratron-actuated relays stop the machine in the event of a dropout, splice or reduction in signal output level indicating an alteration in the soundtrack. The operator may then start up again at 24 frame/sec and listen for any objectionable erasure or re-recording.

With the advent of nontheatrical magnetic-striped release prints, a new inspection problem confronts us. In addition to examination for visible physical defects, we must now also contend with possible damage to the magnetic soundtrack. In optical tracks such defects would be visible; in magnetic recording, however, the faults can be recognized only by ear. Furthermore, the listening speed cannot exceed much over 24 frames/sec. At installations such as film libraries this results in a costly, time consuming operation. A 2000-ft reel of 8mm, normally requiring only 5 min (400 ft/min) for physical examination, would take about 2 hr at 18 ft/min for audio examination.

The sound defect may have been created accidentally or maliciously, since most magnetic sound projectors are equipped for erasure and recording. In any case we can well imagine the hazards of distributing a film whose sound may have been altered.

An Approach

In our study of the problem it soon became apparent that the solution would be in the laboratory recording of the release print. A control signal could be laid down along with the program material during release recording. A low frequency was suggested, and Robert B. Johnson of Kodak's Apparatus and Optical Div. has since made recordings using 30 cps as the control signal.

At 400 ft/min this signal would be reproduced as approximately 660 cps and all other intelligence would be correspondingly increased to over 1800 cps. A sharp-cutting low-pass filter would provide the required attenuation of all but the control signal. Automatic monitoring of the control signal would give the operator an immediate indication of any change in the programmed material since any change which could affect it would also have affected the control track.

The Equipment

Figure 1 is an overall view of the front panel of the inspection machine built to provide these desired results. The film to be examined is loaded on the left spindle and threaded through the various sections in the following order:

(1) emulsion side cleaning tape,
(2) base side cleaning tape,
(3) splice defect detector,
(4) splice counter,
(5) control signal transducer,
(6) enlarged sprocket detector,
(7) torn sprocket detector,

Presented on May 9, 1961, at the Society's Convention in Toronto by Ben Kleinerman, Federal Manufacturing & Engineering Corp., 1055 Stewart Ave., Garden City, N.Y.
(This paper was first received on March 31, 1961, and in final form on July 11, 1961.)

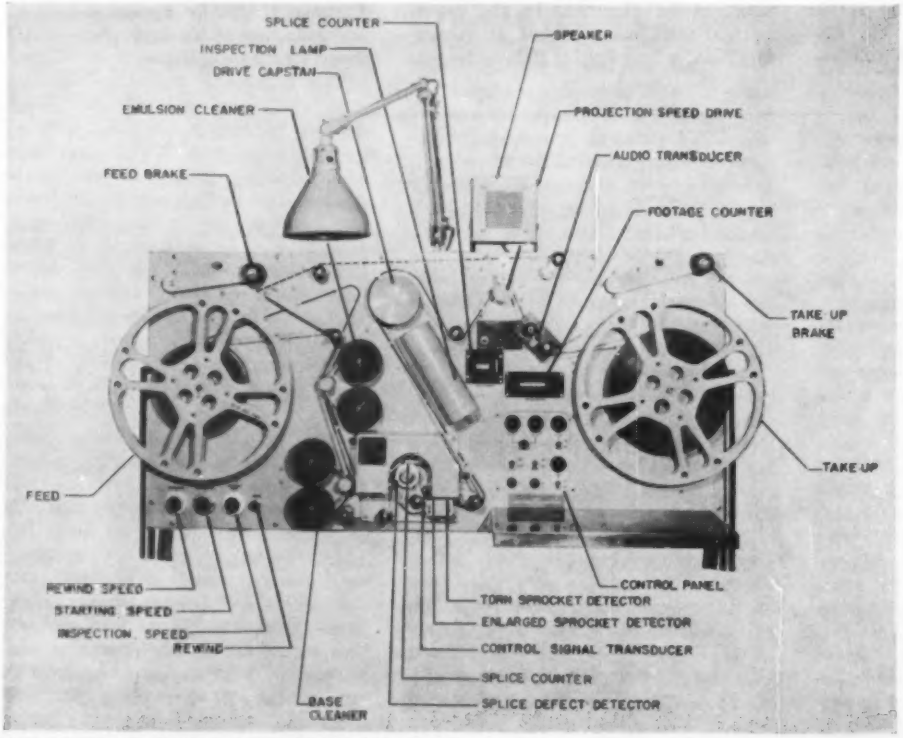


Fig. 1. Front panel of film inspection machine.

(8) inspection lamp,
(9) drive capstan,
(10) footage counter,
(11) audio transducer, and
(12) take-up reel.

The machine is put into operation by simply turning on the power switch. This action energizes the brake solenoids for 3 sec. After a brief warm-up period, the sound defect bulb will light up. This is due to the fact that the control signal is absent and the equipment is nonoperative. The machine is started by pressing the reset button and continues to run until a defect occurs.

The footage counter and splice counter continue to operate as long as there is no defect. When a thick or poor splice reaches the thickness detector, the machine will come to a sudden halt. The drive motor and reel brakes are applied so that the defect comes to a rest directly under the inspection lamp. The operator may now examine the condition of this splice and judge whether or not a new splice must be made. In either case, the machine is started again by means of the resetting switch. In the event of a torn, or even enlarged sprocket hole, the machine will again stop; after examination and repair the resetting switch is used and inspection is continued.

Additionally, the detection of any sound defect brings the machine to a sudden stop, but the operator may restart the film travel at 24 frames/sec by pressing the projection speed button. The sprocket, which was used as a footage counter, now becomes the driving sprocket, driven by a separate motor. The defect, having been picked up by the magnetic head in the detector assembly, therefore, now appears under the inspection lamp. The magnetic head used for playback at 24 frames/sec is positioned so that 5 or 6 sec of unaltered track may be heard before the defect comes into playback position. The operator may then decide whether or not the alteration is objectionable. He may also make a record of the footage at which this defect occurred so that if the defect is not objectionable, he may bypass this point in future examinations. During projection speed examination, the other defect detectors are still operative so that if a fault occurs during the audio examination, the machine will stop and the indicators will reflect the damage.

Figure 2 is a rear view of the machine showing the component parts. The extreme left side shows the relay section chassis containing separate relays and thyratrons for each defect detector. The center portion contains the sound chassis. Above the chassis is the projection speed motor. Slightly to the right of center is the main drive motor and directly below is the audio amplifier. The lower motor is the rewind drive.

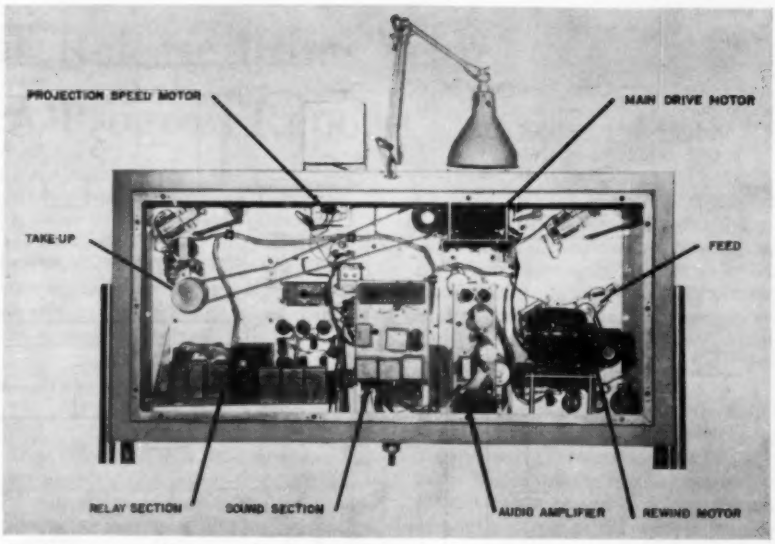


Fig. 2. Film inspection machine, rear view.

Theory and Circuitry

The physical defect detectors are straightforward, microswitch actuated, thyratron controlled relays as shown in Figure 3. The sound defect detector consists of a thyratron which is biased by a negative voltage rectified from the control signal. Figure 4 shows the pickup head which delivers the composite signal to the audio amplifier. The output of the amplifier is filtered and the low-frequency component is rectified to maintain the thyratron in an extinguished state. A reduction in negative voltage at the control grid will cause the tube to fire and energize relay K_1. The a-c voltage to the drive motor is thereby removed and the motor and reel brakes are applied. The sound defect lamp lights up indicating a fault, and if the operator is present, he may press the projection speed button to hear the defect. Depressing this button energizes relays K_2, K_3 and the projection speed motor. The input to the amplifier is switched to the audio transducer; the amplifier output is switched to the speaker automatically and the machine continues to run at 24 frames/sec. At any time while listening the reset button may be pressed to continue high-speed inspection.

Conclusions

A low-frequency control signal, on the order of 30 cps, may be mixed with the regular programmed material without any audible effects when projected by standard means. This signal may be recorded at 15 db below normal recording level without creating noticeable harmonic distortion. A reduction in amplitude of as little as 2% will cause the thyratron to fire, indicating a defect. This system is by no means limited to motion-picture film but is certainly also applicable to magnetic tape.

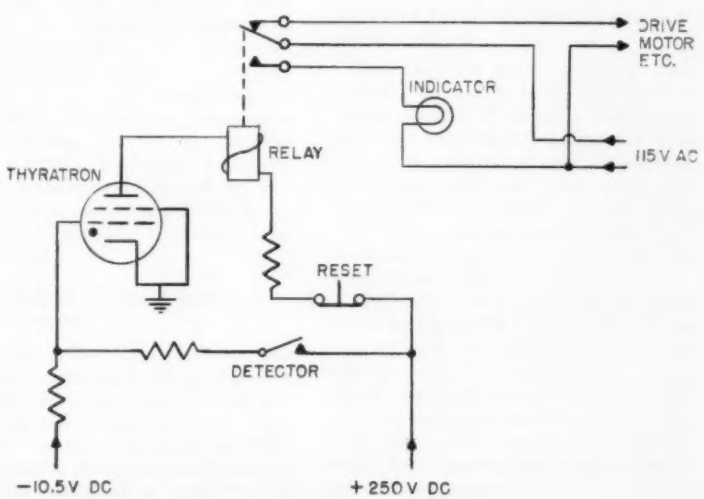


Fig. 3. Typical circuit of physical defect detector.

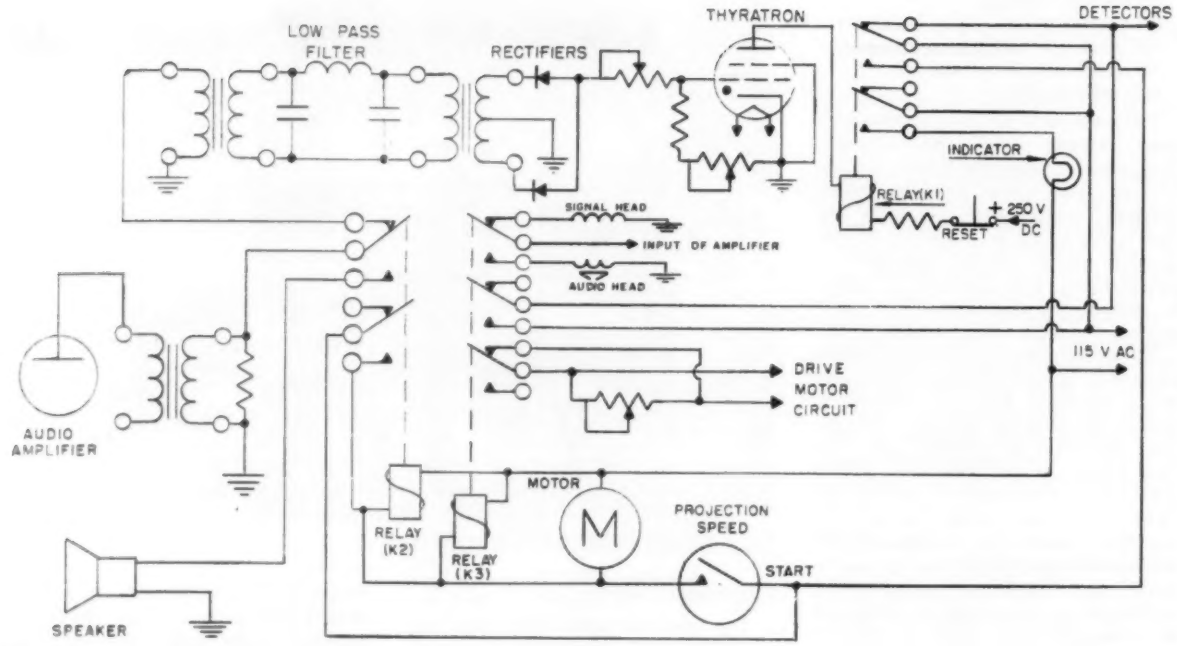


Fig. 4. Sound defect detector.

We would like to thank John Flory, Advisor on Nontheatrical Films, Eastman Kodak Co., and Robert B. Johnson for their encouragement during the preparation of this paper, and for their advice and assistance on many of the technical aspects involved.

Discussion

George Lewin (Army Pictorial Center Long Island City, N.Y.): If there is just a very momentary dropout, will it be detected?

Mr. Kleinerman: If a dropout is on the order of 2% or greater there will be a stoppage of the machine; however, as to a half-cycle, this is one of the drawbacks of the system. In the case of a splice, it is conceivable that the splice could be made at a difference of 720 frames and would then fall exactly into the same configuration as the original recorded 30 cycles. More work would have to be done to eliminate this.

Mr. Lewin: Then I gather that even if the defect just throws the 30-cycle tone out of phase by a fraction of a cycle this will still operate the mechanism.

Mr. Kleinerman: Yes, this is a fault in this system. Now to eliminate this possibility we would require some sort of phase shift detection, as you have mentioned earlier.

Mr. Lewin: Do you expect to use this on 8mm film as well as 16?

Mr. Kleinerman: Yes, the figures we gave are for 8mm. Actually this was a 16mm machine which was in operation at the time we started on this project and we converted it to detect the magnetic sound defect, but it certainly is applicable to 8mm because the inspection speed would still be the same. Actually it would be a difference in the 30 cycles. In multiplying it roughly by 22, you get the 660 cycles, whereas in 16mm it would turn out to be closer to 330 cycles; otherwise everything else would be the same.

Mr. Lewin: Well it seems to me, from experience I've had with dropouts on not only 16mm but even 35mm film, that the occurrence of dropouts in 8mm might be so frequent that the machine would be stopping entirely more often than it should, in other words it will keep stopping on unimportant defects or defects which can't possibly be avoided in 8mm recordings.

Mr. Kleinerman: Well this is true, and actually this paper is meant to set forth a theory, as one approach. But as you mentioned earlier today we would require something that had a time lag, which could be in the filter section as extra capacity to create a time lag; then instantaneous dropout would not stop the machine.

8mm Color Positive Release Prints With Magnetic Sound: A Progress Report

By ROBERT A. COLBURN

Silent 8mm color reduction prints were produced almost 25 years ago. Constant improvements in methods and materials led to many commercial uses. Although a paper on 8mm magnetic sound was first presented to the Society in 1947, little progress was apparent until late 1959. The Geo. W. Colburn Laboratory adapted existing equipment and designed and built new equipment to meet the demand for quality 8mm color sound prints in volume at a cost substantially lower than that of 16mm prints, despite the many additional operations involved.

THIS PRESENTATION is not intended to be a technical treatise, but rather a progress report on the present state of 8mm color sound print production techniques as developed within our own organization.

The production of 8mm color reduction prints was first offered to the amateur trade almost 25 years ago when color film first became available for 8mm cameras. Prints were then made on the early Type A emulsions, one 25-ft roll at a time, on a primitive printer now out of existence, as far as we know. Exposure corrections were made visually during the printing operation by means of changing the lens opening manually. After color duplicating stock was introduced we were able to improve quality, and a new printer was built which made it possible to include automatic scene-to-scene exposure corrections.

By 1946 there was some activity in making quantity release prints in 8mm. Scenic subjects such as Eruptions of Mauna Loa, The Wonders of Luray Caverns, found a ready market for travelers who wished to supplement their own moving pictures. The old problem of quantity printing from a single original film and also the desire to introduce fades, lap dissolves and overlay titles led to the making of low-contrast 16mm reversal masters from which almost any quantity of 8mm prints could be made. While quality suffered somewhat, because of second generation printing, the introduction of Eastman Reversal Print Film, Type 5269 duplicating stock in 1956 made this method commercially acceptable. At one time, attempts were made to lower printing costs by use of a double 8mm color reversal master, but they were abandoned by our laboratory because of poor quality. In the meantime, some activity became apparent in the commercial and industrial field which used the 8mm color film as a demonstration reel for a particular product.

With the development of a continuous magazine for 8mm film in August of 1959, commercial use of continuous loop demonstration films was launched. Two such devices were then available. One, a complete package setup, was developed by Technical Services, Inc., in Farmington, Mich. It uses a Kodak 300 Projector reflecting the image off a mirror onto a rear-projection screen. The entire unit is enclosed in a fiberboard display. Operation can be continuous or actuated for one complete run by a pull ring on the front of the display. This device features a center-drive continuous magazine, connected by a rubber tube to the take-up spindle.

Cousino Electronics Corp. in Toledo had adapted its continuous $\frac{1}{4}$-in. tape Audio Vendor magazine to 8mm film use, calling it a Visual Vendor, and by specially designed brackets could mount it on almost any make of projector. A subsequent refinement of this magazine is at present being used in special projection equipment now on the market.

Before the end of 1959, Eastman Kodak Co., in preparing to market its new Kodak Sound 8 Projector, asked the Geo. W. Colburn Laboratory to supply a demonstration reel with sound, to be packaged with each projector. This was not an easy assignment, especially since thousands of prints were required to keep up with the Eastman delivery schedule. Equipment had to be designed or adapted to handle the numerous steps involved, and methods devised to assure a steady, large flow of the finished prints.

Camras Work on Magnetic Sound for 8mm Projection

Before discussing this relatively new method of producing 8mm color sound release prints in quantity, let me say that "magnetic sound for 8mm projection" is not new. In April of 1947, Marvin Camras of the Armour Research Foundation presented a paper* at a Chicago SMPE Convention titled just that: "Magnetic Sound for 8mm Projection." In it, he describes how several silent projectors were converted to include a magnetic soundhead and demonstrations were made, apparently requiring apologies for lack of "high fidelity" and presence of "wow." His conclusions have a familiar ring:

"It is apparent that magnetic sound has a number of special advantages for the amateur: (1) recordings can be made in the home, without special equipment; (2) they can be played back immediately without processing; (3) records may be erased and re-recorded; (4) old films can be adapted for sound by adding a track; and (5) present silent equipment can be converted for sound."

To me the discussion following the paper is most interesting. *Question:* "What progress is being made toward commercializing the coating process?" *Answer:* "You have to have both things simultaneously. You have to have projectors that will use the film and you have to have the film. The laboratories that coat the film will want the market for it, and those who make the projectors will want the film available. We hope that within a few months there will be some of this film available commercially and possibly some experimental equipment to use it."

The "few months" stretched out into numerous years until The Calvin Co. in Kansas City introduced in 1952 its 8mm magnetic sound projector. Perhaps Mr. Camras' prediction "You have to have both" was the reason this projector was eventually discontinued.

Renewed Activity on 8mm Magnetic Sound Projector

Suddenly, the whole project got into motion. The May, 1960, issue of *PMI* (*Photo Methods for Industry*) pictured no less than six then-available 8mm magnetic sound projectors, four of them completely new, and two merely silent projectors with soundheads attached. Since then many advances have been made and additional projection equipment has been offered.

With the introduction of Eastman, Color Internegative Film, Type 7270, an entirely new method of production became possible. We found that by making direct reduction prints from this material to Eastman Color Print Film Type 7383 (8mm color positive) we could attain a far better quality than by any other intermediate method.

Our first problems at the time, of course, were to perfect the making of

Presented on May 9, 1961, at the Society's Convention in Toronto by Robert A. Colburn, Geo. W. Colburn Laboratory, Inc., 164 N. Wacker Dr., Chicago 6.
(This paper was received on June 28, 1961.)

*Jour. SMPE, 49: 348–356, Oct. 1947.

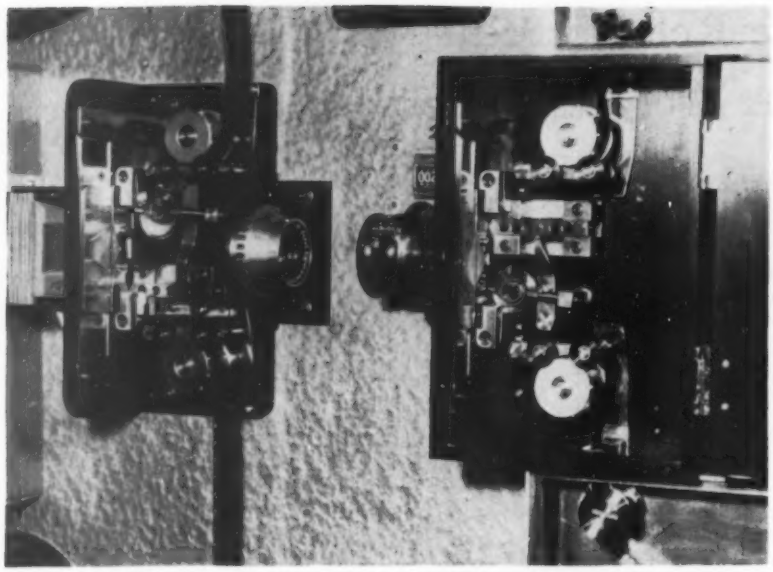


Fig. 1. Special 16mm to 8mm optical reduction step-printer features pilot-pin construction on both heads for maximum steadiness.

16mm color positive sound prints as described in "A Symposium on 16mm Internegative/Positive Release Printing" presented on October 20, 1958, at the Society's Convention in Detroit and published in the September, 1959, *Journal*.

Producing 16mm color positive optical sound release prints is now to us a relatively simple process. After an exposure and color-corrected color internegative picture and a negative optical track have been prepared, prints are made with one pass through a high-speed continuous printer running at 300 ft/min. The color picture is processed, and the optical track is redeveloped to a silver image in a single pass through the processing machine and comes off ready for projection.

For 8mm color sound printing we begin at about the same place, with a suitable 16mm color internegative (the same one used for 16mm release printing, if desired) and preferably a 16mm magnetic mix of the soundtrack, although a 16mm optical positive track can be used satisfactorily. Here all similarity ends.

We found that an entirely new reduction printer had to be designed and built because of the physical and photographic characteristics of the two film stocks involved. Ordinary optical step-printer mechanism design was not adequate, and it was necessary to devise pilot-pin construction for both 16mm and 8mm heads as shown in Fig. 1 to assure maximum steadiness. Printer speed is limited, therefore, to 45 16mm ft/min. A more powerful light source was required than on previous reduction printers to compensate for the slow speed of color positive. No scene-to-scene exposure or color correction facilities are needed, however, since these corrections are made in the internegative. There is provision for overall color correction to accommodate differences in emulsion sensitivity.

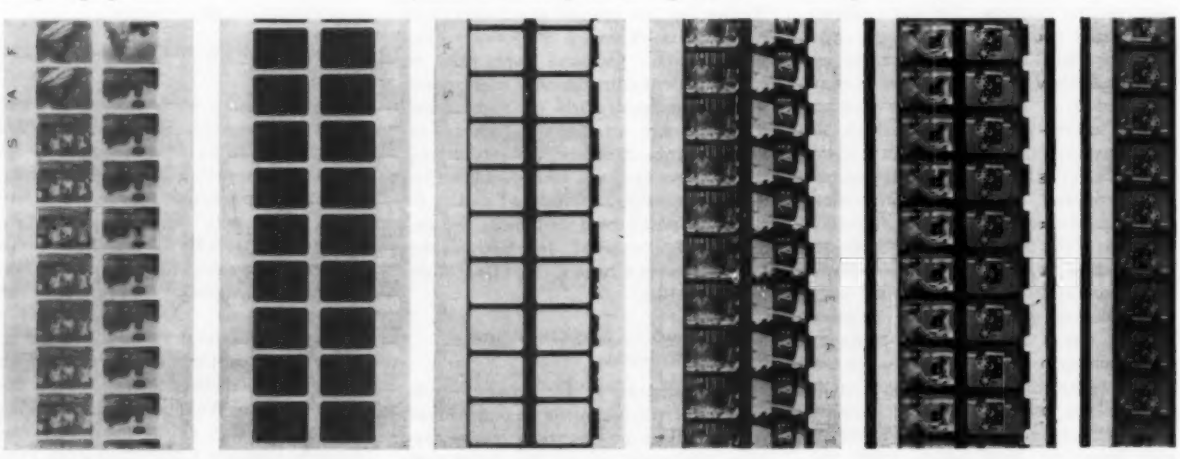
Frame Line Consideration

The next problem was a matter of frame line. The full 16mm frame must be printed to standard 8mm camera aperture size, so that no appreciable portion of the picture area will be cut off by the 8mm projector aperture. As can be seen in Fig. 2A, a wide, clear area is left at the frame line as well as along each side. A slight misalignment of the projector aperture would show this area on the screen.

Thus a double 8mm frame line mask, as shown in Fig. 2B, was prepared on special equipment used to make steadiness test films, to a size about midway between camera and projector aperture sizes, to assure overlap all around. This, printed by itself, looks like Fig. 2C. Each roll of double 8mm print stock then must go through this second frame line printing operation on a high-speed continuous printer before processing, to produce a composite print, as shown in Fig. 2D.

Fortunately, the processing procedure is normal except that the usual optical sound redevelopment applicator is bypassed.

The next step is an emulsion hardening treatment, either Vacuumate or Permafilm, to improve projector steadiness. At this point a preliminary inspection is made to eliminate further work on defective prints. Then the film is Magnastriped in the area between the perforations and the edge of the



A B C D E F

Fig. 2. (A) double 8mm optical reduction print of picture only shows wide, clear frame line; (B) frame line mask is made on special test film camera; (C) frame line mask is printed on continuous 16mm printer; (D) composite print of picture and frame line mask completes printing operation; (E) magnetic sound stripes are added to processed print; and (F) film is slit to single 8mm form for transfer of sound signal.

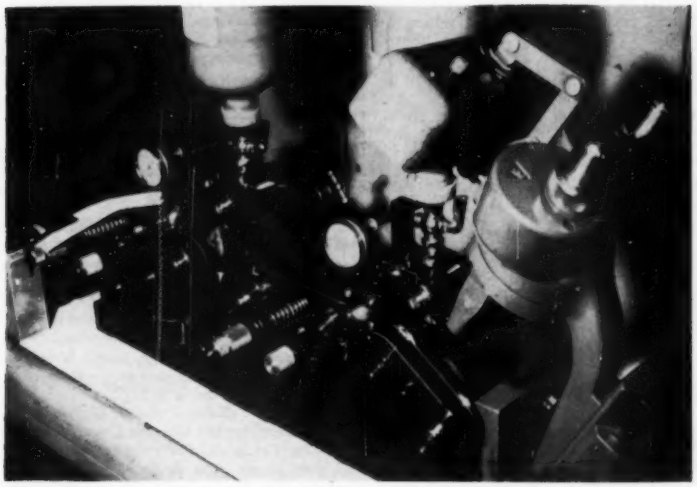


Fig. 3. Two 30-mil magnetic oxide sound stripes are applied to the processed film between the perforations and edge of film on the base side.

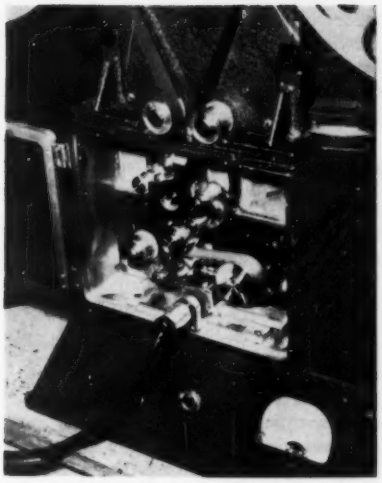


Fig. 4. A Maurer 16mm Film Phonograph reproduces sound from 16mm magnetic or optical soundtracks.

film. The stripe is approximately 30 mils wide. Heretofore, since most recording stripes on 16mm were 50 mils or 100 mils in width, and the 30-mil stripe was used primarily as a balance stripe, the application of the narrow stripe was not critical. However, with the narrow stripe we found that very small variations in the consistency of the striping material could vary the thickness beyond normal tolerances for good sound recording. Minute lumps could also cause momentary dropouts. Thus, a special rolling mill was needed in order to condition the material for consistent application. On the striping machine, shown in Fig. 3, two heads in tandem apply the stripe first to one edge and then the other. Figure 2E shows the final result.

Original plans were to then transfer the sound to both edges in the double 8mm form with one pass, recording forward on one side and backward on the other. But expediency and lack of time for research made the use of a Kodak Sound 8 Projector itself the most practical re-recording medium. Thus, the next step became slitting into two separate 8mm films, on a specially built slitter. Figure 2F shows a single 8mm print ready for recording.

The re-recording playback unit is a Maurer Film Phonograph, shown in Fig. 4, modified to accommodate an adjustable magnetic head, in addition to the optical playback. This was set up first with a single Kodak Sound 8 Projector, the speed being governed by a synchronous motor. It was discovered that the construction of the projector made it possible to line up any number of projectors in tandem, as shown in Fig. 5, and by removing the gate and pull-down mechanism, extending the drive shafts and connecting them together, to drive them all with a single motor. All nylon rollers in the transport mechanism have been replaced by carefully machined brass rollers to minimize "wow" from this source. The original amplifiers have now been replaced by improved units which permit recording at a lower level, reducing distortion. A $\frac{1}{25}$-hp synchronous motor is used to drive the whole assembly and is equipped with a heavy flywheel to help stabilize the sound. With the present setup, four recording units are operated at one time. Incidentally, in the Kodak Sound 8 projector, the original film was only 100 ft in length, making it possible to splice eight internegatives together in a single roll for repeat printing. The 16mm magnetic master recording is set up in an endless loop, so that one single continuous operation will record 32 individual prints.

Then comes final inspection by actual sound projection. At this stage, any picture defects that escaped the previous inspection, or any sound dropouts, are detected. The prints then go to final mounting and packaging, ready for delivery.

Steps Toward Further Improvements

As can be seen in comparing the amount of labor involved in handling the numerous phases of 8mm color sound production by the direct reduction method with 16mm printing, higher labor costs more than eat away the savings in film stock and processing in low-quantity runs, and only in larger quantity can there be any substantial saving in the per print cost of a given subject.

Tests have been continuing for some time for release printing from a double 8mm color internegative. Many improvements have been made since testing began. First of all an improved light source in the optical reduction printer made it possible to use an $f/5.6$ lens opening in making the double 8 internegative. Improved film movement mechanism reduces unsteadiness in the internegative stage. But it was found that attempting to print both sides of the internegative at once on a continuous printer caused misalignment of the perforations opposite the sprocket. Thus, while the print on the sprocket side showed excellent results, the other print was quite inferior. Substitution of an 8mm drive sprocket for the 16mm sprocket, placement of pressure rollers directly over the 8mm frame and replacement of the aperture drum masking off the opposite frame are modifications made on our high-speed continuous printer (300 ft/min) making it possible to produce 8mm color contact prints of uniform quality by two passes through the printer. From the quality standpoint, the definition now seems adequate for some uses, such as travel films for resale. On the other hand, while this double-8mm internegative method would reduce

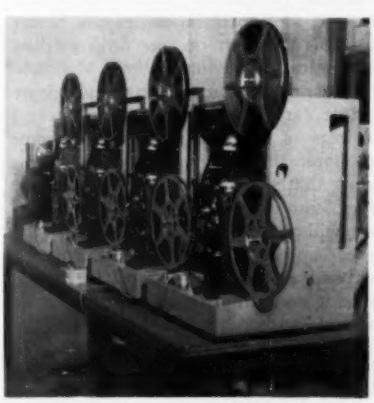


Fig. 5. Four interlocked Kodak Sound 8 projectors re-record sound on four 8mm magnetic-striped prints at one time.

labor costs considerably, most commercial productions would require the best possible quality that can be produced only by the direct reduction step-printer method previously described.

The first industrial company, as far as we know, to go into an extensive 8mm color sound sales program is the DoAll Co. of DesPlaines, Ill. They have engineered their own special carrying case that will accommodate a Kodak Sound 8 Projector and up to 22 individual subjects 10 to 20 min long, each describing and demonstrating a different piece of heavy industrial equipment. They have more than 150 projector units in the field. In the case of the Eastman demonstration reel, the film was produced specifically for 8mm, but in the case of many of the DoAll productions, the films were originally produced for 16mm release. The 8mm versions are being used as an additional medium for a much wider distribution to specific sales prospects.

We feel that this is an important new and supplementary use of the motion-picture medium, destined for wide usage. A great deal of interest is being shown in the educational field as well as the present industrial use, and while I do not care to make any predictions, I will say that a second 16 to 8 reduction printer specifically for color positive is already proving inadequate to supply the demand. We have therefore started work on a new printer design using the same direct step-type frame-for-frame reduction method, which will increase production of a single machine manyfold, with less wear on the internegative. This certainly will enable us to supply prints at a substantially lower cost than at present without sacrificing quality. A new, more rugged sound transfer machine is also being built to replace the Kodak Sound 8 projectors. There is no doubt that a great deal of other progress in 8mm color sound release printing is being made.

Discussion

George Lewin (*Army Pictorial Center, Long Island City, N.Y.*): What is the lineal speed of the film when you're doing the recording?

Mr. Colburn: The film is recorded at 24 frames/sec. We have attempted to record at higher speeds but there was too much distortion in the sound so we reverted to the 24 frames standard speed.

Mr. Lewin: In the whole matter of 8mm film, now that it's evidently becoming more commercialized and is about where 16mm film was eight or nine years ago, we may be asked by the Army, as we were then, whether magnetic tracks are feasible for our type of production. Then the considered opinion of everybody was that magnetic sound was not advisable for film such as the Army's training films or orientation films, because of the ease with which it would be possible to erase, or damage or change the message on the film. It seems to me that this is a pertinent question with 8mm and I wondered if anyone has any comments on it.

Mr. Colburn: From the start for commercial applications we have thought it would be advisable to have only playback projectors rather than ones in which the soundtrack could be erased or changed; however you might want the erase and record heads if you were going to send the film overseas or to put a different language on.

Mr. Lewin: Well, of course, it still is easy to erase a whole reel of film even without unreeling it if anybody is inclined to do it.

Thomas Hope (*Eastman Kodak Co., Rochester, N.Y.*): I have checked with the Organization of European Economic Cooperation over there, and they report that in four years of using magnetic film they've had only one experience of wiped-off track in many thousands of prints.

Louis Forsdale (*Teachers College, Columbia University, New York*): Many teachers, particularly in elementary schools and perhaps in secondary schools, would be delighted to have their students get involved in the process of making their own tracks to put on film. This would be particularly attractive if it were possible also to put back the original track if the students' track did not work out too well. The idea is to get the children involved in this particular medium.

The Manufacture of 8mm Prints at Technicolor

By W. E. POHL

Methods used at Technicolor for preparation of 8mm magnetic-sound release prints made from 35mm Eastman Color Negative or 16mm Ektachrome source material are discussed.

Because the manufacture and sale of 8mm release prints is in its very early stages at Technicolor, this should be considered as a preliminary report rather than as a report on our final method of making such prints.

The preparation of 8mm sound release prints can be carried on from several sources of original material. It seems probable that in the first stages of this work that subjects that have been made for 35mm or 16mm release or industrial use will also be made in 8mm. Since the great appeal of 8mm to industrial and educational users is one of cost, we believe that it is essential to set up methods for manufacturing 8mm prints that will deliver the best possible quality compatible with low cost. If only a few prints are made, print-downs to 8mm from the negative used in producing either the 16mm or 35mm release are probably feasible and equipment to accomplish this can be made available. For large volume orders, contact printing from a multiple-rank dupe in the final stage of print preparation appears necessary to keep the speed up and the costs down.

We have explored more than a dozen ways of making an 8mm sound release print from 35mm Eastman Color Negative source material with such obvious changes as working from silver separation masters and interpositives, as well as printing down to the 8mm from 35mm in either the final stage or in two stages, printing first to 16mm and then to 8mm. We have also explored the making of 8mm prints from 16mm source material, both by direct print-down and direct duping methods.

Most of the source material for 8mm prints is either Eastman Color Negative, 16mm Ektachrome or successive exposure negative used for cartoon photography. Since the contrast or gamma specifications to which each of these several source materials are developed differ from each other, it is necessary to make a correction for the source material in preparing intermediate or separation masters for printing down to the 8mm printing dupe if the duping method is used. Additional problems are posed when several source materials are intercut in the final result.

We have explored various methods for making what we call a quadruple-rank dupe, which is made on specially perforated 35mm stock. Visualize if you will four 8mm prints side by side, all heads out and all emulsion up, then add to the unperforated edge, 3 mm of stock and a set of perforation holes in this 3 mm. Stock perforated in this way can be used to produce commercial prints on a 1:1 contact printer, printing from a quadruple-rank dupe onto Eastman Color Positive. The quadruple-rank dupe will carry four identical 8mm images side by side and can be prepared from

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suitable masters or interpositives using a beamsplitting prism printer to minimize the amount of printing required to obtain the four images.

Possible advantages of the quadruple-rank system could be the use of existing equipment so that the release prints can be printed and developed on the same printer and developer as are used for printing double-rank 16mm prints. No additional printing or developing equipment would be required in the release channel, and inspection could be carried out on all four prints at a time on the 16mm double-rank projector. In printing and developing, we use only the two outside set of holes. The remaining three sets of holes come into use only when the film is slit and are then used for projection purposes.

There are also substantial economies in the application of the magnetic soundtrack, since all four prints can be striped in the 35mm-width form with a single pass through the striping machine. Similarly, all four prints can be electrically printed with the magnetic sound with a single pass through the magnetic printing machine.

We have experienced unexpected trouble with grain when working with some of the combinations which can be outlined from various source materials and have spent a considerable amount of time in studying means of avoiding these difficulties.

We are also studying the application of the Technicolor imbibition process to the problem of making 8mm release prints from both 35mm and 16mm source material with very gratifying results. This application appears most interesting on the basis of the tests so far completed, and we believe the benefits of printing down directly from a relatively larger area negative to be particularly beneficial in producing 8mm prints of good grain and definition characteristics.

Developments in Magnetic Striping 8mm Sound Film

By EDWARD SCHMIDT

Although the idea of coating a stripe of magnetic material on the edge of motion-picture film was the subject of American patents as early as 1919, it was not commercially feasible for 8mm film until recently. Successful 8mm sound projectors became possible after the development of high-precision, long-wearing magnetic heads and low-cost compact electronic components. Two machines for coating magnetic stripes on film have been produced by Soundcraft, the first for coating 16mm raw stock, and the second for coating 8mm processed film.

THE YEAR 1960 saw the commercial introduction of magnetic sound 8mm projectors. This promoted the design and construction of two new striping units: one for single 8mm film and the other a high-speed laboratory production machine for prestriping raw stock prior to exposure and development. These units represent a continuation of the development of the wet striping process which was first demonstrated by Reeves Soundcraft at the October, 1950, Lake Placid SMPTE Convention. Why did it take ten years for magnetic sound on 8mm film to become a commercial reality? For that matter, perhaps an even more interesting question is, why did it take fourteen years from the time of the original Marvin Camras demonstration of November 14, 1946, at a meeting of the Acoustical Society of America in Chicago? A brief history of the development of 8mm sound on film is extremely interesting and will serve as a proper background and understanding for the 1960 and 1961 work which we will describe.

Many years ago the practicability of obtaining sound for motion-picture film through the medium of a magnetic stripe and magnetic heads had been explored. When Soundcraft applied for Magna-Stripe patents in 1950, the patent office cited a number of references to American and foreign patents. The earliest of these was 1884, but this had no significant bearing on the process or method. However, in 1919 there were two patents issued which separately thoroughly covered the basic article of a stripe of magnetizable material on perforated film for the production of moving pictures with sound. One of these patents was especially significant. Here the inventor had placed, alongside the perforations, a pod of collodion containing magnetizable particles of iron. His patent drawings illustrated the use of a ring-type head, but he drew the film down through the gap between the pole pieces.

Continued attention was paid to the perfection of striping systems from the days of those early patents and culminated in Marvin Camras' aforementioned demonstration. He repeated this demonstration on April 5, 1947, at an SMPE Convention in Chicago.*

For an illustration of additional activity in the field, Lloyd Thompson presented, at the same convention in Chicago, a paper entitled "Movie Sound 8mm Projector." He summarized his paper, "The first commercial 8mm sound projector has been introduced with the sound on a disc running at $33\frac{1}{3}$ revolutions per minute. Automatic synchronization is used and the turn table and projector are not connected. 8mm sound films for use with the projector are available."†

Camras' demonstration and subsequent application work by many experimenters clearly indicated the technical advantages of magnetic recording for the motion-picture industry and demonstrated that a striping system should have considerable application in the market place. Characteristics such as frequency response, signal-to-noise ratio and freedom from deterioration with use, plus the inherent simplicity of the magnetic recording and reproducing process itself, ensured that the process should someday find acceptance. Striped film represents the only practical method of obtaining sound on 8mm film.

Amplitude Modulation Problems

However, there was a serious stumbling block — that of amplitude modulation. The magnetic recording process depends upon intimate contact between the head and the surface of the magnetic oxide. This problem is not too severe in the case of 35mm film, with its high lineal speeds and relatively wide track areas, but when we reduce the speed to the neighborhood of 3.6 in./sec and have only 25 mils of track width available for the stripe, we find that it is necessary to employ high unit pressures between the surface of the stripe and the head

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(This paper was received on July 12, 1961.)

* See Robert A. Colburn, "8mm color positive release prints with magnetic sound: a progress report," in this issue of the *Journal*.

† See William D. Hedden and Kenneth B. Curtis, "Early 8mm sound developments," in this issue of the *Journal*.

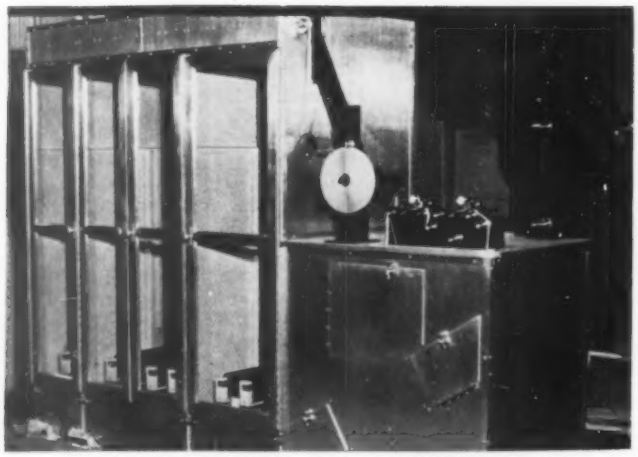

Fig. 1. General view of high-speed 16mm striping machine.

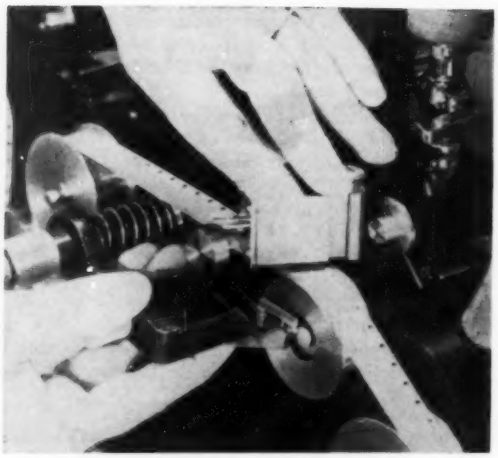

Fig. 2. Close-up of striping head, 16mm striping machine

itself to maintain good intimate contact. The amplitude modulation on 8mm film is extremely severe with head-to-stripe contact pressures of the order which are satisfactory for 35mm applications at their high lineal speeds and wide widths. Furthermore, the fact that the stripe is so close to the perforations results in severe sprocket hole modulation unless high unit pressures are employed to maintain intimate contact between the film stripe and the head.

Mu-metal heads 25-mil wide have extremely limited life under conditions which permit satisfactory performance in the 8mm field. Therefore the application of striped film for the 8mm industry had to wait for the development of hard, long-wearing heads. This problem has been solved through the use of Alphenol pole tips. Similarly, refinements in producing heads at low costs with very small gap widths, approximately ¼-mil wide, were required in order to obtain the necessary frequency response on a reliable basis.

One should also comment that the use of solid-state electronic components and printed circuitry, which of course are relatively new techniques, was also required to reduce the cost and volume requirements of the electronics by a significant degree. It is this combination of long-wearing heads and miniaturized electronics which has resulted in the introduction of successful 8mm sound projectors.

Development of Stable Striping Mixture

In August, 1953, Soundcraft built the first successful multistripe unit for producing CinemaScope prints for the Twentieth Century-Fox film *The Robe*. Since that time more than a billion feet of film have been striped using the process. Its success was due to the development of a very stable striping mixture which had a high degree of thixotropy. This is the property of a mixture to assume a gel-like consistency when stagnant but to have relatively free flowing properties in motion. This characteristic permits long shelf life and also ensures that the freshly applied wet stripe will not sag and deform during the drying process after it leaves the applicator. In this fashion a flat uniform cross section of the stripe is achieved.

The physical properties of the dried stripe are equally critical in applications for projection purposes. The stripes must have low frictional characteristics, must be extremely well bonded to the surface of the base, must be very flexible and must have unusually high thermal softening properties for plastic materials. It must be remembered that the optical systems of projectors often subject the film to extremely high local temperatures during the time the film is in the gate of the projectors. Minor refinements have been made in the process since 1953, but the fundamental characteristics are unchanged.

Prestriping Large Quantity of 8mm Film

We saw three areas of activity in the field of 8mm striping during 1960. The first of these was the striping of over three million feet of unexposed reversible color film for use in the Fairchild Cinephonic 8mm camera. Here the stripe is applied in total darkness on laboratory equipment in the Soundcraft plant. This film is run through the camera and after exposure is subject to normal processing. No contamination of the film emulsion by the magnetic oxide or of the processing solution occurs nor has any deterioration of the recorded sound due to the development process been noted. Very few technical problems were apparent during the manufacture of this significant quantity of prestriped 8mm film.

Design and Operation of 16mm High-Speed Striping Machine

During the course of this work it became apparent that for reasons of economy of transporation and service, it is desirable to perform the raw-stock striping operation in the facilities of the producers of raw stock and on a local geographical basis. Therefore a production 16mm-width machine was designed and built (Figs. 1 and 2). It has an operational speed of 200 ft/min. Every feature that is necessary to guarantee freedom from handling problems associated with the extremely sensitive unexposed photographic emulsion is included. It must be installed in an air-conditioned laboratory environment and supplied with humidity-controlled warm air with a maximum of approximately 90 F for the drying operation. It is designed for one-man operation, the loading section, striping head and take-up reel and all controls being located on one table at the head end of the machine. All rotating idlers on the precision striping head are mounted on class 3 ball bearings.

The emulsion surface of the film, within the picture area, does not contact anything throughout the entire film path, except in the striping head area itself. Here it is insulated from scratches and handling problems through the use of thin, conductive-surfaced 16mm loops. These loops are made of Mylar and are coated with a pigmented conductive resin. This system has established its ability to produce large quantities of prestriped raw stock without introducing scratches, pressure marks, rubs, dirt, etc., on the most sensitive emulsions.

After the film leaves the feed spindle, it passes into the first section of the drybox, which is actually a feed and take-up elevator section. This is to permit splicing of one roll onto the other for continuous operation. The

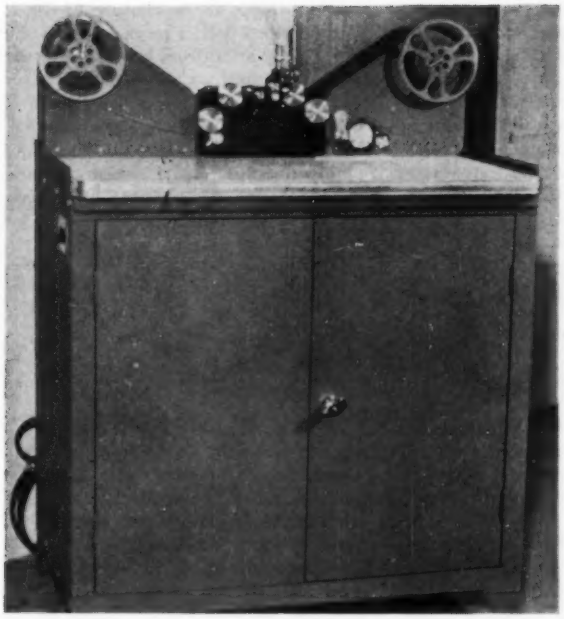

Fig. 3. General view of Model S-8 striping machine.

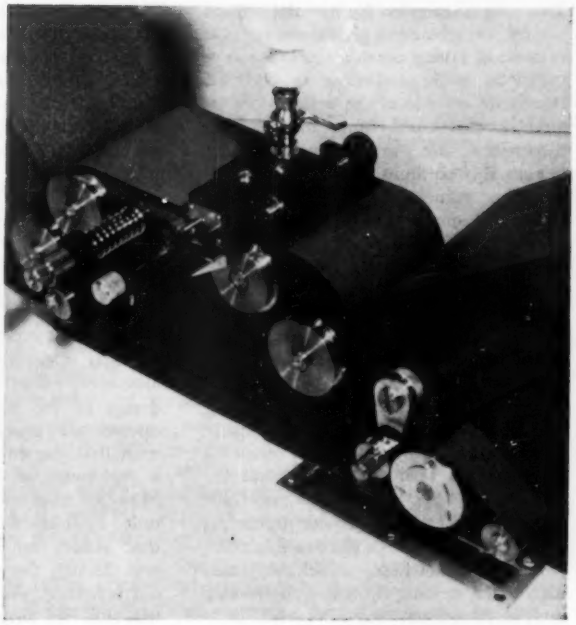

Fig. 4. Close-up of striping head, Model S-8 striping machine.

first section of the drybox is served with humidity-controlled room-conditioned air. This is necessary to minimize curl, which is occasionally noted on unexposed raw stock. The film passes from this elevator over the striping head. The striping is achieved through the use of two sapphire applicators and the film is held in intimate contact at the orifice of these applicators by means of sapphire pressure shoes. The oxide is fed to the film through the applicators from a closed circulatory system at a predetermined rate which is controlled by an adjustable header. The control of the thickness of the dried stripe is a combination of the dimensions of the orifices on the applicators and the viscosity of the mixture.

Since this equipment uses a significant quantity of dispersion during the 24-hr operating day, a circulatory system is provided. The slow-running gear pump takes the dispersion from a stainless-steel pot, located in the striping table, through an Ertel filter. This filter is capable of removing foreign particles above 10 microns. In addition to the circulatory system, a stainless-steel mixing pot is provided on the coating table. It is also equipped with a filter and a pumping system, and has a capacity of 16 gal. For this application the dispersion is shipped in a high-viscosity condition, approximately 1550 centipoise. Prior to use it is cut to operational viscosity of approximately 550 centipoise by the addition of a suitable amount of methyl-isobutyl ketone. Viscosity is best measured with a Brookfield Viscosometer in which the speed of the rotating cup can be varied through different ranges, although the use of the Ford-type cup is adequate for production control purposes.

Wide widths of freshly applied stripe must be protected from sudden drafts and thermal shock. The film path is therefore arranged so that the film runs through a channel of relatively low air volume characteristics into the back of the drybox. The first section of the drybox is not equipped with any air supply but is connected to the exhaust system. In this fashion some concentration of solvent fumes is achieved, permitting slow evaporation of the solvent, which is necessary during the early part of the drying schedule. By the time the film leaves the first drying section and enters the 90 F area, over 75% of the total volatile solvents have left the stripe. (This figure depends to some degree on the width of the stripes being applied, and slow drying is especially necessary on relatively wide stripes — 100 mils and up. It is not so critical for 25-mil wide stripes.)

The film is exposed to the 90 F air for approximately six minutes during the normal drying schedule and then it returns to the first section once again to re-establish room temperature and humidity conditions on a take-up elevator. It is fed out of this take-up elevator by means of a one-direction sprocket onto the take-up spindle, which is equipped with a level-wind system and tension control to ensure the delivery of carefully wound reels which are in a shippable condition. A three-position switch controls the function of the take-up elevator and take-up spindle. In one position the take-up elevator operates at line speed. In a neutral position the drive is disconnected from the elevator shaft and take-up spindle simultaneously. This causes the roll to stop to permit loading an empty spool onto the precision-wind take-up spindle. In the third position the take-up elevator and spindle run at 25% above the line speed so that the elevator can be emptied in preparation for the next roll change.

There is an end-of-roll alarm which operates on a signal obtained from a hole punched in the head end of the roll during feed-in splicing. The activating system is an air stream so that no mechanical components are required to touch either side of the films.

A tachometer, line-speed control and other instrumentation are also provided on the striping table.

A microscope with a reticule eypiece is mounted on the end of the striping head for measurement of track width and position, etc., during white-light operations. Observation of stripe width is also practical during the striping of some of the lower speed color and pan films during dark conditions by providing grazing columnated green safelights.

The equipment is constructed entirely of metal. Aluminum is used for door frames, etc., and interior surfaces are painted with baked enamel paint. A choice of drybox rollers is available, either all stainless steel or bakelite. The use of stainless-steel rollers is recommended for operations involving the striping of some of the high-speed photographic emulsions which tend to have static sensitivity.

8mm Striping Machine for Photofinishers

Also during 1960 a model S-8 striping machine was designed (Figs. 3 and 4).

This unit is intended for installation and use by the advanced photofinisher. It is capable of laying down a single stripe of magnetic oxide according to SMPTE standards, outside of the perforations on already developed 8mm film. Two dispersions are made available for use on this equipment. One of these is for the standard-position film, the bulk of the material in the market place, where the stripe is placed on the base side. The other is for the occasional non-standard-position prints which require striping on the emulsion side of the film. The dispersion used for base-side striping is the same material that is used for unexposed photographic raw stock, whereas the dispersion used for striping on the emulsion side cannot be used in the striping of raw stock and is restricted to developed prints. In both cases the dispersion for the 8mm striping machine has been adjusted to normal operating viscosity requirements, prior to shipment.

This little machine, unlike the 16mm high-speed striping unit, has no elevator and is completely self-contained. It is designed for local installation in ordinary facilities. It requires space which is relatively clean and dirt-free, provided with 110-v a-c power and a convenient window or exhaust duct to install the exhaust hose. The oxide is fed to the striping head from a half-pint polyethylene bottle. No circulatory system is provided. The mouth of the bottle contains a re-usable 200-mesh stainless-steel screen. A steel striping applicator is ordinarily supplied for this application.

The striping head itself is an 8mm version of the 16mm striping head and is built to the same conditions of precision, except that in this case sleeve bearings are employed, rather than ball bearings. It does not require the use of precision transfer ways or microscope. The drybox is exhausted with a small self-contained blower directly to the outdoors by means of a flexible hose, attached to the back of the machine. No provisions are made for raising the temperature of the drybox air since drying of the narrow 25-mil stripes is not especially critical. Threading and operation are straightforward, and every effort has been made in the design of the equipment to minimize operational problems. The design is such that the entire film path is under a maximum of six ounces of tension. Many hours of operation of the prototype unit established the interesting fact that splices on old dried prints will run through the striping machine without breaking, whereas these same prints will not run through a standard 8mm projector.

Every effort was made to minimize the equipment cost to ensure its adaptability for a wide variety of striping. It has been built around a standard metal cabinet which was modified by the insertion of air baffles and separators. Standard link chain is used for all transmission. All shafts in the drybox are removable by the loosening of two screws. This is necessary to facilitate cleanup and washing procedures. Guide separators are provided on all drybox rollers to ensure that the film cannot jump from one spool to the other. All machine components, other than the stainless-steel striping surface, are either anodized or baked enamel. The feed spindle and take-up spindle are equipped with standard friction clutches. Precision 2400-ft capacity 8mm reels are made available as accessories for this equipment.

Operational speed is 30 ft/min. Observation of the cabinet is possible at all times through a window on the side of the machine. All rollers in the drybox are of Nylon and are undercut to eliminate danger of scratching prints, etc.

At no time is more than a half pint of striping solution and a pint of wash solvent required for the operation of the 8mm machine; therefore fire danger is minimized. Obviously, enforcement of ordinary safety rules such as rigid "No Smoking" is required. The blower and drive switch are interconnected so that the drive will not operate unless the blower is operating. The exhaust ports are at the base of the cabinet so that solvent vapors are exhausted even if the doors are opened, thus eliminating the possible concentration of solvent odor in the room.

While every attempt has been made to make the machine simple to operate and reliable in operation, some operator training is required. This can be accomplished either in Soundcraft's Danbury plant or on a local basis.

Precision Magnetic Striping of 8mm Film

By F. J. KOLB, JR., R. C. LOVICK, J. R. PEER and E. M. WEIGEL

Magnetic sound recording on 8mm film demands close tolerances on both stripe dimensions and magnetic-audio performance because the system requires a narrow stripe and a low film speed. The requirements of good design of a striping machine are reviewed with particular attention to positive film positioning and stripe placement at the striping point, constant speed film drive and minimum film tensions. A coating head and a corresponding high-viscosity magnetic dispersion are described that together define stripe width, thickness and contour. This system has been used by the Eastman Kodak Co. to provide 8mm Sonotrack coatings since May, 1960; the quality control data from this operating experience indicate good production control. Operating techniques are presented for the guidance of processing laboratories who may wish to design similar striping systems.

Introduction

This paper is concerned with a technique for applying a magnetic stripe to motion-picture film. The details presented here refer specifically to processed 8mm film because the equipment was designed in conjunction with a sound-on-8mm program. However, the system is not restricted to films of this size, but, with obvious modifications, may be used with a variety of products.

The introduction of 8mm sound through the medium of magnetic striping has opened new areas to many industrial, educational and religious organizations. Major advantages are portability and low cost of both equipment and film. Many applications in these fields are particularly well adapted to 8mm presentation, especially where small-sized audiences are involved.

Heretofore, the sound movies generally available for home use were in the 16mm size. These have not been attractive for extensive amateur use, mainly because of the relatively high cost of equipment and prints. As silent 8mm projectors are gradually replaced with sound machines, the home consumer market for 8mm sound prints should expand to an appreciable degree.

General Considerations

There are three major ingredients that combine to form a satisfactory magnetically striped 8mm product — the film, the dispersion, and the equipment. The net result is a film-supported magnetic stripe that is required to meet certain performance and quality standards.

The dimensions and placement of the stripe are dictated by the geometry of the system in which it is used. Processed films will be striped on the side that faces the light source of the projector: on the support of originals, optical prints and even-generation contact prints; and on the emulsion side of odd-generation contact prints.

For both 8mm films and 16mm films perforated along both edges the standard stripe width is 30 mils. For 16mm films perforated along one edge the standards recognize stripe widths of 50 mils and 100 mils.

Dimensional Tolerances in the 8mm Magnetic System

Magnetic sound on 8mm is dependent upon acceptable quality from a recorded track about 19-mils wide scanned at 2.4 in./sec. This imposes limitations on track placement, width, profile and uniformity that are in some cases more severe than those imposed on 16mm or 35mm magnetic sound. It becomes vitally important to the future of the 8mm sound system that commercial magnetic striping set a high quality level.

There are a variety of tolerances that must be coordinated if the system is to function with a maximum practical useful track width. Compromises in the entire system may be made, but it becomes important to realize:

(a) other factors being equal, the wider the useful track the better and more practical the sound reproduction, and

(b) early agreement on elements of interchangeability should be sought but every effort must be made not to hamper technical progress.

The striping system described in this paper has been found to meet the tolerances in track width and placement as specified in current ASA Standard PH22.88-1956. However, in a magnetic sound system only that portion of the track in direct contact with the head is functioning effectively.[1] This emphasizes the importance of controlling the stripe profile as discussed by Bach.[2] The contact width of a stripe will always be less than the projected width, increasing further the uncertainty in effective stripe positioning. It is a further advantage of this system using a high viscosity dispersion through a precision metering orifice that the stripe tends to retain the orifice profile. This represents a further precision advantage over previously described striping procedures.

Current Practice

Current practice in film striping embraces several primary techniques and many modifications thereof. For example, a precoated tape of proper width may be laminated to the film; it may either be laid onto the unprepared base or emulsion or into a premilled groove. The major requirements are good cementing and proper alignment since thickness and contour uniformity are controlled during dispersion coating. Constancy of width and straightness of the laminate are a function of tape slitting.

The bead applicating method of striping depends on a rotating wheel to transfer dispersion from supply pan to film. Here the obvious mechanical control of wheel width, relative speeds and film-wheel separation is much less important than the properties of the dispersion. Formulation is primarily responsible for the preferential wetting characteristics that cause the dispersion to leave the wheel in favor of joining the film. Control of width and thickness provide critical limitations.

In any coating operation that places the dispersion supply above the film the stripe must end up on the film through the force of gravity. Flow coating falls in this category. It has the limitation, however, of generally defining only the wet width of the stripe. Thickness control is a function of the dispersion which must be fluid enough to flow in an uninterrupted stream onto the film, yet viscous enough to resist further spreading once it gets there. Physical controls are not very effective on stripe cross-section and margin tolerances in this method of coating.

The striping operation described in this paper involves a completely closed, extrusion-type system. As such, it places less restrictions on dispersion formulation than the "open" systems previously mentioned. For example, compositional changes in dispersion resulting from solvent evaporation cannot occur within the supply and metering system because no opportunity for solvent escape is provided. Furthermore, physical separation of formula components is prevented by the continuous agitation provided by the pumping system. In addition, accurate stripe contour and

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(This paper was received on June 14, 1961.)

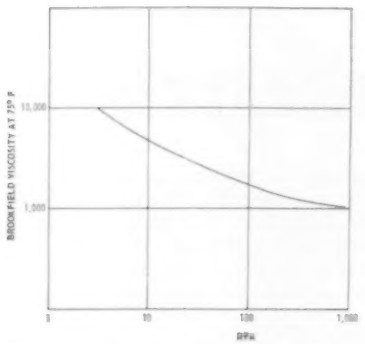

Fig. 1. Viscosity characteristics of Kodak Sonotrack dispersion.

positioning are easily obtained because the hopper, located above the film, has an extremely precise orifice. Through this orifice the dispersion is extruded at a precisely metered rate to give a stripe with a well-defined cross section.

Dispersion

The striping method chosen will govern the formulation of magnetic dispersion to a large degree. In those systems wherein the dispersion supply is uncovered, loss of solvent to the atmosphere must be considered. Since the solids content of the dispersion increases as the solvent escapes, such loss can produce measurable non-uniformities over the length of the coating. It is generally difficult to prevent the loss of solvents in bead-coating and flow-coating systems.

Systems that do not provide continuous agitation to the dispersion supply may have settling problems. Magnetic dispersions tend to separate on standing; local concentrations of components can be reflected in stripe quality. These factors, then, assume a major role in directing the choice of dispersion components.

The published version of the dispersion formula developed for 16mm Kodak Sonotrack striping is over five years old.[3] Since then minor modifications have been made for various purposes. By making additional, slight changes this formula has been modified for the processed 8mm coating method about to be described. The dispersion now being used has the following composition:

	Percent by Weight
Magnetic Iron Oxide*	21.74
Nitrate Dope†	43.48
Ethylene Glycol	1.96
Butyl Cellosolve	13.59
Amyl Acetate	19.23
	100.00

* C. K. Williams Company, 655 Clinton Ave., Newark, N. J., Type IRN-110,

† 40-60 SS type cellulose nitrate..... 10.0%
Butyl alcohol..... 4.3%
Cellosolve..... 30.0%
Amyl acetate (commercial)..... 55.7%

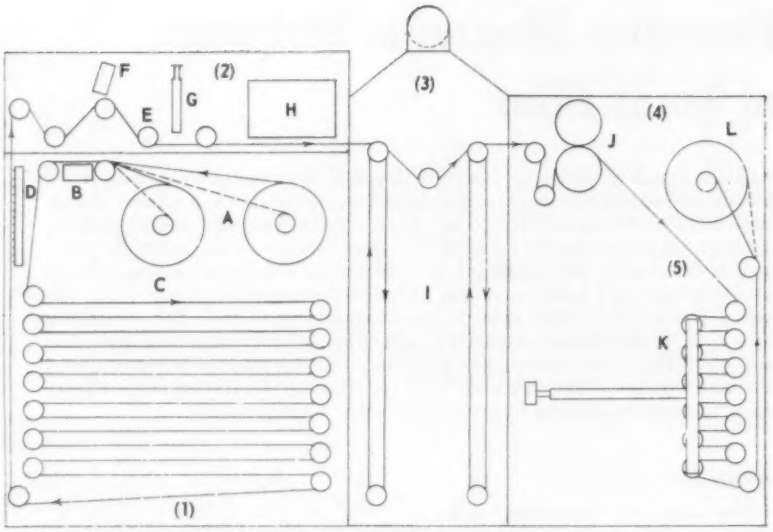

Fig. 2. Schematic of Kodak 8mm Sonotrack Striping machine.

1 – feed section
2 – coating and inspection section
3 – drying cabinet
4 – calender section
5 – take-up section
A – film supply reels
B – splicer
C – feed elevator
D – static eliminator
E – main drive roller
F – striping hopper
G – inspection microscope
H – gross defects monitor
I – dry cabinet racks
J – calender rolls
K – take-up elevator
L – take-up reel

Magnetic dispersions represent complex systems whose rheological properties are dependent upon every detail of preparation and history — in addition to the initial formulation. These materials are charged into porcelain jars and are ball-milled with $\frac{1}{2}$-in. flint pebbles for 36 hr. This dispersion is filtered through a 100-mesh stainless-steel screen immediately upon discharge from the mill.

Dispersions so prepared show the rheological properties specified in Fig. 1. The successful performance of this dispersion in the metered extrusion coating equipment to be described depends upon the relationship shown in Fig. 1 as well as upon the wetting properties of the dispersion on the film surface, upon the solids content of the dispersion, etc. These factors not only are important in establishing the dimensions of the metering orifice and the flow rate that will produce a usable stripe, but they have a major importance in determining the stripe contour — a subject of great importance to be discussed later.

Striping Machine

The machine designed and constructed for 8mm Sonotrack striping is shown schematically in Fig. 2. Basically, it consists of (1) a film supply section containing stock rolls and feed elevator, (2) a coating station with inspection facilities, (3) a drying cabinet, (4) calender rolls and (5) a take-up section. The dispersion supply system is a supplemental unit and does not appear in this diagram.

The machine with all doors closed is shown in Fig. 3. This L-shaped unit is housed in a room that is 10-ft long by 8-ft wide.

The feed end or film supply section appears in Fig. 4. Two stock roll spindles (A) have been provided to facilitate changeover from one roll to another while striping, thus allowing for uninterrupted operation. Since the elevator at C will accommodate 50 ft of film, a little over 1 min is allowed for changeover at the present operating speed of 40 ft/min. This changeover is facilitated by splicing block B which is designed to help in making tape splices. It consists of two spring-loaded clamps for holding the film ends.

The coating station is illustrated partially and occupies the position designated F. A detailed description is presented later.

The drying cabinet, for which no specific illustration has been provided, has four banks of pulleys which accommodate 250 ft of film. Air velocity was chosen to balance such other factors as noise, film flutter, etc. Because the solvent vapor concentration is very low, about 95% of the air is recirculated with provision being made to add fresh air as required.

Upon leaving the drying cabinet, the film passes between calender rolls shown at J in Figs. 5 and 6. Here the stripe is compressed to give the desired surface and density characteristics.

The take-up elevator K (Fig. 5) and wind-up station L are similar respectively to the feed elevator and film supply. This elevator allows 1 min to remove finished reels.

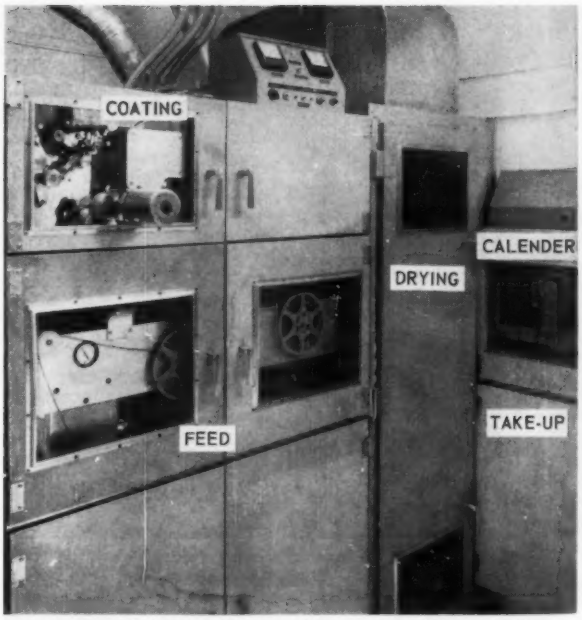

Fig. 3. General view Kodak 8mm Sonotrack Striping machine.

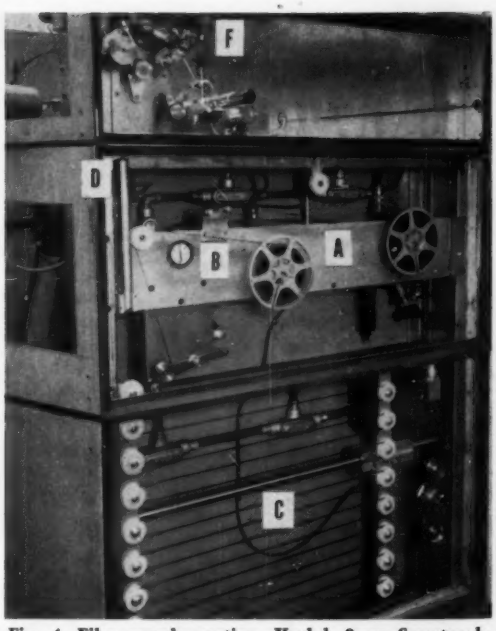

Fig. 4. Film supply section, Kodak 8mm Sonotrack Striping machine.

A – film supply reels
B – splicer
C – feed elevator
D – static eliminator
F – stripe applicating unit

Film Transport: One of the key requirements in the transport of a film only 8mm wide is the assurance of low tension in the strand to prevent abnormal film distortion and minimize film breaks at splices.

To keep frictional resistance at a minimum each of the nylon spools on the two elevators and in the drying cabinet is mounted on air lubricated bearings. These bearings are made of porous metal into which pressurized air is introduced eliminating all solid to solid contact. The elevators are actuated by constant tension springs, each of which exerts a pull of $4\frac{1}{2}$ lb. Divided among the eighteen strands on the elevator, this maintains a tension of 4 oz throughout the machine, except at the coating station.

The spindles upon which the supply reels are mounted actually are the extended shafts of torque motors. Voltage to these motors is limited by a regulator coupled through a rack and pinion to the feed elevator. Thus, tension is maintained whenever the elevator reaches the limit of its extension. The take-up reel and elevator comprise a somewhat similar combination.

Power for the main drive is supplied through a 1/150-hp synchronous motor. It is transmitted through a rubber-

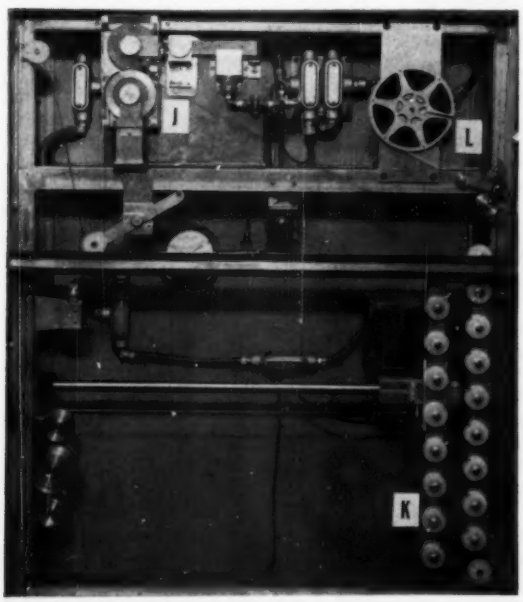

Fig. 5. Calender and film take-up section.

J – calender rolls
K – take-up elevator
L – take-up reel

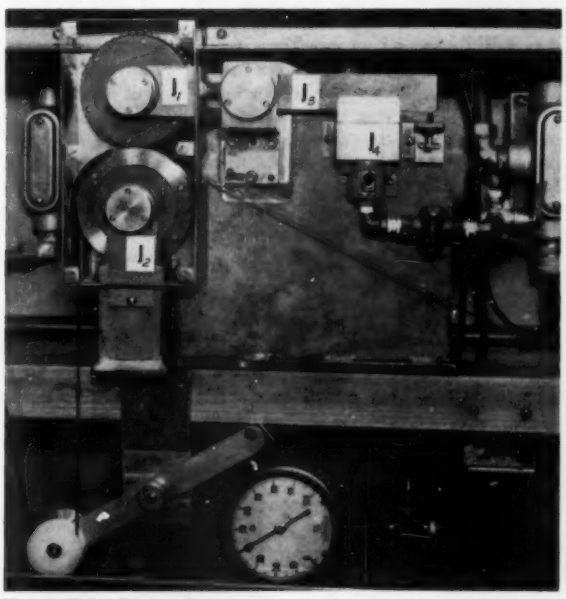

Fig. 6. Calender section.

J_1 – upper calender roll
J_2 – lower calender roll
J_3 – lever arm, upper calender roll
J_4 – air pressure cylinder

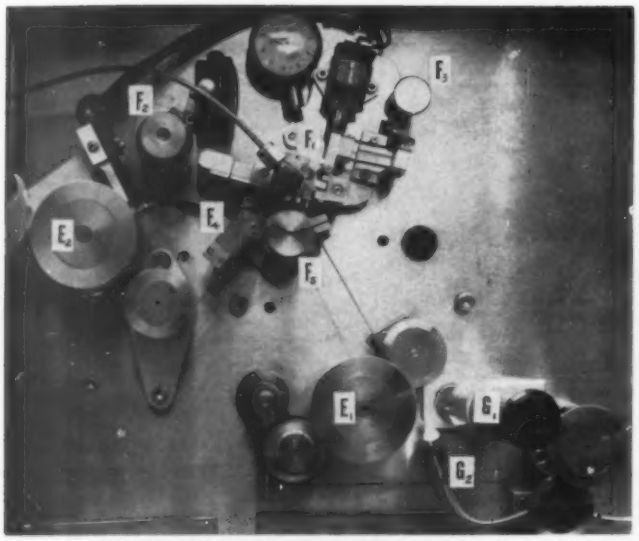

Fig. 7. Stripe applicating section, front view.

E_1 – main drive roll
E_2 – back tension torque roll
F_1 – hopper
F_2 – hopper positioning screw, lateral
F_3 – hopper positioning screw, vertical
F_4 – film guiding mechanism
F_5 – film support roller
G_1 – inspection microscope
G_2 – inspection microscope illuminating lamp

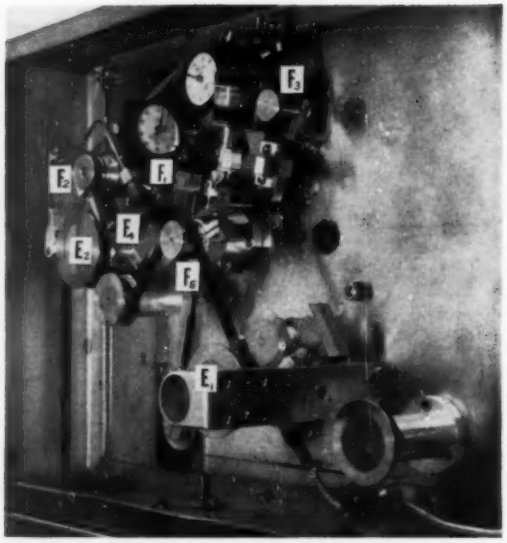

Fig. 8. Stripe applicating section, oblique view.

E_1 – main drive roll
E_2 – back tension torque roll
F_1 – hopper
F_2 – hopper positioning screw, lateral
F_3 – hopper positioning screw, vertical
F_4 – film guiding mechanism
F_5 – film support roller

tired roll shown at E_1 in Figs. 7 and 8, which illustrate, respectively, full front and oblique views of the stripe applicating section. A similar roll E_2 tends to be driven in the opposite direction by a regulated torque motor thereby maintaining controlled higher tension in the film as it passes under the coating hopper.

Coating Unit: The coating hopper, F_1, is held on a dovetailed mount, which is adjustable in two planes. F_2, a compound screw, moves the mount in a horizontal direction perpendicular to the plane of the illustration. Its traverse is approximately 0.005 in./revolution. This movement positions the hopper with respect to the fixed reference planes of the mechanical coating assembly. With proper film guidance this can be translated into control of the margin between the edge of the film and the outer edge of the stripe. The thumb screw, F_3, imparts motion in a vertical direction thus setting the separation between the hopper and the film. Dial indicators provide a means of measuring the extent of adjustment in either direction. During coating the separation between the hopper and the film is maintained at approximately 0.004 in.

Precise control and positioning of the film at the point where it receives the dispersion is unquestionably one of the most critical parts of the striping operation. To provide the accurate lateral positioning required is the function of sapphire edge guides F_4. The guide bearing on the perforated edge which is to receive the stripe is rigidly placed on a fixed bracket and forms a reference surface. The outer sapphire, supported by a strip of phosphor bronze spring stock, bears on the unperforated edge of the film thus holding it against the indexing jewel.

Vertical movement is restricted by maintaining proper tension in the film strand over the hardened ground and polished roller F_5 which supports the film as it is being coated.

Hopper: The assembled hopper appears as shown in Fig. 9. Dispersion enters from the feed line through a coupling at A and exits to the film through an orifice at C. This path is more evident in the exploded view of Fig. 10, which shows the two side plates and the 30-mil separator. The width of the orifice, which defines stripe width, is governed by the thickness of the separator plate. The height of the orifice, which aids in the control of stripe thickness, is set by the adjusting screw B. This screw bears on the upper surface of the separator and compresses channel A-C to the desired height which is approximately 0.002 in.

The hoppers require precise adjustment and careful handling. For this reason a fixture is used to hold the hopper in position under a microscope for inspection and adjustment purposes.

This hopper design has proved to be very successful in producing precision stripes in conjunction with a dispersion of the rheologic nature previously described. Since the dispersion shows some increase in viscosity and a definite yield point immediately as the shear becomes zero (the time of coating) it tends to remain in the contour defined by the exit orifice.

Good striping, accordingly, requires not only careful and precise mechanical design, but also a dispersion with compatible rheology. Experiments have established the validity of the obvious conclusion: either one of these two requirements cannot by itself insure a good stripe. Only a compatible combination is effective.

Drying: Drying of the wet stripe is a perfectly straight-forward operation. Air at 100 F enters the drying cabinet at the rate of 1000 cu ft/min. With a cabinet cross-sectional area of two square feet this amounts to a linear velocity of 500 ft/min. Approximately five minutes of drying is allowed.

Calendering: As the solvents evaporate in the drying cabinet the dispersion deposit becomes rather porous. Since sound quality and physical characteristics can be measurably improved by eliminating this porosity, the stripe is compressed immediately upon leaving the drying cabinet. At this point it is sensibly dry but still retains enough solvent to allow some reforming.

The calender rolls (Figs. 5 and 6) are 4 in. in diameter. Each is a compound roller with a highly polished tungsten carbide bearing surface. It has been found that materials softer than tungsten carbide wear to an unsatisfactory degree. A worn, roughened, or dirty calender roll will emboss a pattern of marks on the coating that is readily reflected in sound quality. For this reason the surfaces of the calender rolls must be maintained scrupulously clean and uniform at all times.

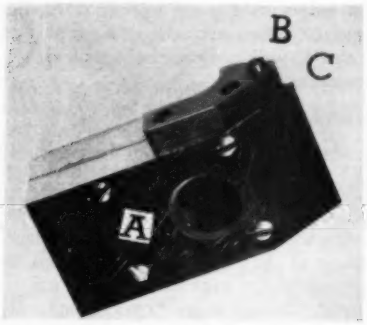

Fig. 9. Hopper assembly.

A – dispersion entrance port
B – orifice adjusting screw
C – dispersion exit orifice

The lower calender roll is driven while the upper is a floater. This supplements the film drive, although very little is required at this point because of the low friction in the drying cabinet.

The air cylinder at J_4 in Fig. 6 is supplied with air at 40 psi. Transmission through level arm J_3 results in pressure applied by the calender of 31.4 lb.

Dispersion Supply System: Development of a hopper and accurate control of film speed and position are, of themselves, insufficient to produce the degree of uniformity desired in the magnetic stripe. Required also is a precise metering of dispersion to the hopper. The device designed to accomplish this purpose is presented in Fig. 11.

The dispersion supply tank at A is a stainless-steel beaker of 16-oz capacity equipped with an electrically driven propeller-type stirrer. This agitator was provided when it was discovered that the normal recirculation rate was not enough to completely eliminate settling of the dispersion.

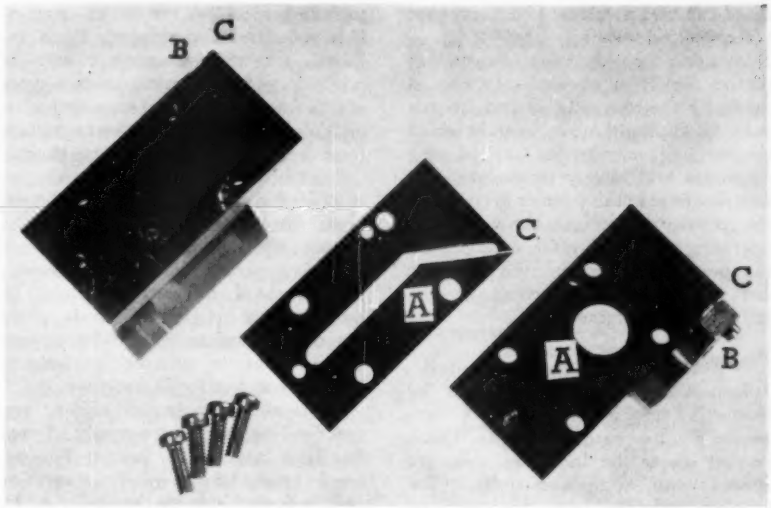

Fig. 10. Hopper details.

A – dispersion entrance port B – orifice adjusting screw C – dispersion exit orifice

Uniform particle size and freedom from foreign material are essential to the production of high-quality stripes. Slugs and particles of dirt coated in a magnetic stripe prevent intimate contact with the record and playback units thus resulting in dropouts. With positive displacement of the oxide provided by the pumps it is practical to filter all dispersion at the coating machine. The filter, shown at C, contains a wire-wound element with an equivalent pore size of 0.003 in. If the dispersions are properly prepared, this filter does not require servicing for several weeks. It is easily cleaned when the pressure drop becomes excessive.

Two *identical* gear pumps, D and E, constitute the heart of the dispersion supply system. They are powered by separate gears mounted on a common shaft F. Each of these gears contains a different number of teeth, and this is the key to the metering principle employed. Pump D, which draws dispersion from the supply tank, is driven by a gear containing 44 teeth. It delivers dispersion to the tee shown between C and E in the schematic of Fig. 12. Pump E, on the other hand, is driven by a gear that contains only 41 teeth and cannot remove the flow from the tee as rapidly as supplied. The excess, therefore, is diverted through the remaining branch of the tee to the by-pass valve G and it goes from there to the hopper. Delivery from pump E returns to the supply tank. A careful selection of gears together with a proper choice of shaft

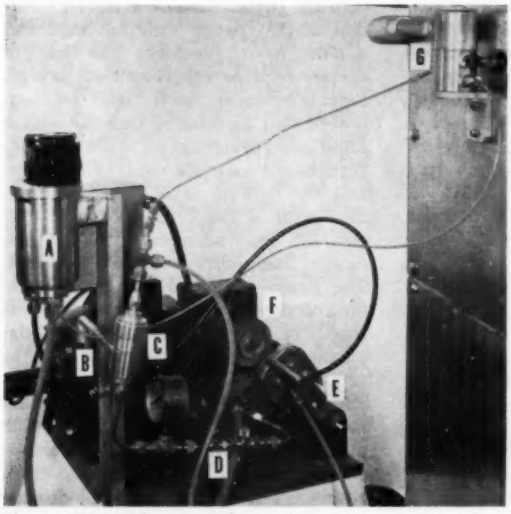

Fig. 11. Dispersion metering unit.

A – supply tank C – filter E – slow pump
B – motor D – fast pump F – pump drive gears

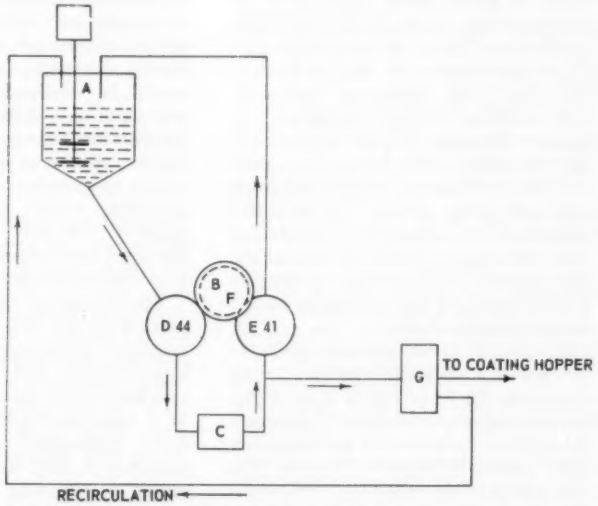

Fig. 12. Schematic of dispersion metering unit.

A – supply tank D – fast pump F – pump drive gears
B – drive E – slow pump G – by-pass valve
C – filter

speed can give a volume of delivery that will cover a wide range.

Provision for uninterrupted operation of the dispersion circulation system is made by the solenoid-operated by-pass valve G. During those intervals in which the striping machine is at rest, the dispersion will merely recirculate. The unit functions in this manner to eliminate the necessity of cleanup at the end of each operating period. Thus far, no abnormal pump wear has been observed and there has been no adverse effect on the stability of the dispersion.

Production Striping

Inspection of all film received for magnetic striping service is a prerequisite to the coating operation. This is carried on as the individual rolls are spliced into compound rolls. (The striping machine can accommodate 1600-ft reels.) Each splice is examined and repairs of all types are effected where required. Tape splices receive added attention because it has not been possible to obtain acceptable adherence between the magnetic dispersions and polyester tape splices. This type of splice is trimmed with a special fixture to remove the tape in the area where the stripe is to be applied, which will allow coating of the dispersion directly on the film.

Because of the rubbing action of guides and sprockets in film handling equipment, dirt count normally is high at the film edges. When a liquid stripe is applied over such dirt each particle becomes engulfed and, when the coating has dried, appears as a distinct bump. These bumps prevent adequate contact between the stripe and the sound head of the recording and/or playback equipment. They also cause irregularities in the edge of the stripe. When a sound head scans such an irregular stripe, sound quality noticeably deteriorates. These considerations have led to precleaning all film during the inspection and mounting operation. The cleaning solution comprises one gram of Hercules PE Tetrastearate per liter of methyl chloroform. This serves to remove unwanted foreign materials from the film surface. In addition, because of the lubrication provided, it insures proper projection quality of the film. Adherence of the stripe to the film is not affected by the presence of such a minute quantity of wax.

Motion-picture film is also prone to the buildup of static charges during rewinding. At D in Fig. 4 is an 18-in. inductor for the Kodak Static Eliminator Power Unit. Its function is to remove any static potential acquired by the film from any previous handling. Such action minimizes attraction of dirt particles to the film during coating.

It is essential that the finished stripe conform to the established physical and recording specifications on all types of film submitted for striping. Films received for striping may consist of originals and duplicates, several types of film from one or more manufacturers, and films with many different surface treatments. The spreading characteristics of the liquid dispersion change as a function of the film surface. Although there are some consistent differences among various films, in general, it is not possible to predict the degree of spreading. Even if adjustments could be predicted for individual rolls, it would not be practical to change the coating system controls at the one-minute intervals required for 50-ft sections.

Fortunately, the hopper striping system described here is not grossly affected by these undesirable factors. For example, the viscosity of the dispersion used is limited only by the ability of the pumps to force it through the system at the desired rate. (Pressure within the hopper is approximately 6 psi.) Furthermore, the hopper orifice very accurately defines the cross section of the emerging stream.

It is not enough, however, that the system define the cross section of the stream simply as it emerges from the orifice. It must also make provisions for preserving this form by preventing any longitudinal stretching or compression. This is done by imparting to the emerging stream a linear speed equal to that of the film. The proper combination of pump speed, linear velocity, and orifice shape gives the desired results. Within reasonable limits the width and thickness of stripe are independent of the amount of separation between hopper and film.

Once the stripe has been deposited on the film in the desired width, spreading must be either closely controlled or completely eliminated. If the final stripe dimensions were to be determined solely by the natural spreading tendency of a liquid dispersion, nonuniform results would be obtained. The greater the amount of spreading allowed the greater the variation among various film samples. Rigid control can be effected only by proper formulation. The cohesive forces prevailing within the stripe must be equal to, or only slightly greater or less than, the attracting forces that tend to spread the wet dispersion.

The extrusion hopper supplies dispersion to the film surface in a rectangular cross-sectional area that is approximately full stripe width. The viscosity of the dispersion is maintained at a high enough level (approximately 6,500 centipoises) so that spreading tendency is held to a minimum. This serves to maintain both the required width of stripe and the desired margin between the outer edge of the stripe and the edge of the film. Fortunately, with this technique, the dimensional variations in stripes that occur by reason of film surface differences are minimized and remain well within the specified tolerances.

Standards

The ASA Standards in effect at the present time specify stripe width and placement only. There has been no difficulty in meeting these standards with the hopper coating system. Placement of the stripe is readily varied by means of the micrometer screw adjustment. Changes in width are made by (1) the hopper adjusting screw, (2) control of pump speed and (3) change in the width of the hopper separator plate.

Quality Control

A magnetic stripe should be judged for both physical quality and sound quality. Physical quality is concerned with appearance, adherence, wear characteristics, and dimensional considerations; sound quality is measured in such terms as output, frequency response, amplitude modulation and practical listening tests.

Routine control of 8mm magnetic striping starts with the dispersions. The quality of the dispersion is checked by a viscosity measurement on each batch produced. Control limits have been established and no dispersion that is outside the specified limits is accepted for production. In addition, the first coatings made from each batch of dispersion are checked for physical and recording characteristics on the finished stripe.

Monitoring: It is advantageous to employ a device as soon as practical following the coating to detect the loss or narrowing of the stripe. Inasmuch as the stripe at this point will have most of the solvents still in the coating any monitoring device must avoid contact with the stripe. Resolution of the variation of the coating sufficient to detect minute flaws precludes the use of devices such as the reluctance bridge. Experimentation with the problem proved that an infrared detector with a suitable optical system could discriminate between the magnetic oxide of the stripe and the dyes in most color films. A filter such as the Kodak Wratten 87C cuts off the radiation of a tungsten exciter lamp below about 800 mμ. The density of the dyes in most color films decreases rapidly above a wavelength of 800 mμ. The density of the magnetic stripe in the range 800 to 1200 mμ is sufficient to permit discrimination between the stripe and the maximum density of the dyes of color films. The response of the silicon photocell is negligible above 1200 mμ. This system is not effective when black-and-white films are being coated.

The actual monitor detector (located at H in Fig. 2) consists of two tungsten

exciter lamps, two sound optical systems from projectors, and two photocells and suitable guides for positioning the film. The projected image height of less than 0.001 in. permits close control of width of stripe and detection of very small defects. Both the width and defect detectors notify the operator only in the event of increased transmission of infrared radiation.

The monitor consists of a d-c amplifier direct coupled to a low-voltage cathode follower, the output of which is direct coupled to a thyratron. This is necessary to permit detection of slow as well as rapid changes. A relay in the plate circuit of the thyratron energizes an alarm and grounds the thyratron plate. The cathode follower was found necessary to isolate the d-c amplifier and also to present a low-impedance source for the thyratron. The short operational time of the thyratron permits long tube life without significant change of characteristics.

Routing Testing: Daily maintenance checks are made on the machine to insure absolute cleanliness. All idler rollers, edge guides and drive rollers must be free of foreign particles and dried oxide or the surface of the stripe may be disturbed. The calender rollers receive daily cleaning with solvent. Coating hoppers are handled and stored with extreme care to prevent burrs, nicks or any type of damage to the coating orifice.

The coating machine is set up for production and checked by striping a short length (50 ft) of test film. This test is measured immediately for the width, thickness and position of the stripe. Only after this has been done and standard operating conditions established is customers' film fed onto the machine.

Routine control measurements of significant physical characteristics are made and plotted on control charts. These measurements include the width, thickness, position and surface quality of the finished stripe. All inspection of the stripe is carried out under at least 40× magnification. In addition to the measurements made on the finished stripe the electronic monitor on the machine is set to sound an alarm whenever the position or width of the wet stripe does not conform to standard. This monitor will also detect skips in the coating.

Sound reproduction capabilities of the stripe are determined on a special recorder reproducer. This recorder has no intermittent pulldown and utilizes a double inertia wheel system to achieve good film motion at the very low film velocity used with 8mm magnetic films. Less frequently, magnetic stripes are tested for compatibility with a Kodak Sound-8 Projector and a foreign and another domestic sound projector.

The basic signal source is a low distortion sine wave generator. Listening tests employ a professional-quality tape recorder operating at 15 in./sec as the signal source.

Certain tests are considered so significant that daily checks are required. Amplitude modulation is considered to be most important. Frequency response, sensitivity and output for a given distortion level and noise are frequently checked.

Amplitude modulation measurements are made using a laboratory-quality intermodulation analyzer. A signal frequency of 2000 cps is considered adequate for routine analysis of 8mm stripes. On occasions a test at 7000 cycles may be made. Comparison of amplitude modulation data from coating to coating requires careful maintenance of head position, head wear, stripe erasure, demagnetization of the heads, cleanliness of the test samples and uniformity of the film transport. Significant evaluation of the amplitude modulation test further requires that the bandwidth of the low-pass filter be known and that the response of the filter and measurement system be excellent to a few cycles per second. The passband of the high-frequency filter must be flat within a decibel. The equalization of the reproduction amplifier must also provide a constant output over this same frequency range. Unless these conditions are fulfilled, speed variations will be interpreted as amplitude modulation.

The other instruments used in the analysis of the stripe characteristics are a harmonic analyzer, an a-c vacuum tube voltmeter, an oscilloscope and a recording oscillograph. The harmonic analyzer is used to specify recording levels relative to the distortion present in the recording. A double channel recording oscillograph provides a ready analysis of the source of defects and a permanent record for future reference.

Conclusions

The system described makes it possible to apply a magnetic oxide dispersion on a variety of film surfaces to produce a sound stripe of high quality that meets current ASA Standard PH22.88-1956. The magnetic stripe produced by this system has excellent sound reproduction capabilities. This should make sound on 8mm film attractive to all 8mm camera users and should open many new uses in the industrial and professional field.

Many people other than the authors in the Manufacturing Experiments and Color Technology Divisions of the Eastman Kodak Co. contributed to the success of this program. Special acknowledgment should be made of the contributions of A. E. Beguin, J. J. Graham, E. Jewett and H. F. Ott.

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2. W. Bach, "Engineering aspects of 8mm and 16mm magnetic film striping for high quality audio or data recording," Presented at the SMPTE Convention in Los Angeles, May 1960.
3. Thomas R. Dedell, "Magnetic sound tracks for processed 16mm motion-picture film," *Jour. SMPTE, 60:* 491–500, Pt. II, April 1953.

Discussion

Harry Sombor (General Electric Co., Syracuse, N.Y.): Do you prestripe, also?

Mr. Weigel: This equipment was designed and built to stripe processed film in 8mm width, but I'm sure that the iron oxide and the machine are unable to discriminate between raw stock and processed film. If the machine can be operated in the dark I'm quite sure the application can be made.

George Lewin (Army Pictorial Center, Long Island City, N.Y.): Just how is infrared light used to monitor the film?

Mr. Weigel: It monitors the presence or absence of the stripe and intermittency in the stripe, a mislocation of the stripe (referring to the lateral positioning), and also it will detect variations in width, within certain reasonable limits.

Mr. Lewin: What wave length do you use and what about the thickness? Won't it detect variation in thickness as well?

Mr. Lovick: The choice of the wavelength which you would use to detect isn't important; you simply use a wavelength somewhat beyond that which will be effective for the dyes, probably in the neighborhood of 900 millimicrons and not so far out as to get to the area where you have complete transmittance of the track. You can use infrared transmittance to detect variations in thickness. We are not currently using it in that fashion although the original equipment was designed to do that.

Mr. Lewin: Do you detect this with a photoelectric cell? Is that your guiding factor?

Mr. Lovick: Yes, silicon-type photocells. We filter a tungsten source with Wratten 87C filters to put the peak sensitivity in the range of around 900 or 950 millimicrons.

Ray Burlay (Minnesota Mining and Manufacturing Co., St. Paul, Minn.): What about the actual thickness and the variation in thickness, roll to roll, overall?

Mr. Weigel: I can only say that our stripe stands within the tolerances that are recommended. The thickness is approximately four- to five-tenths of a mil. The thickness uniformity and reproducibility are controlled by the precision metering functions of the coating equipment. Magnetic recording tests on the finished stripe, as a quality control procedure, have confirmed this uniformity during nearly a year of commercial operation.

Mr. Burlay: What is the effect of the calendering roll on the coated stripe; does this squash it down a little?

Mr. Weigel: It will compress the stripe somewhere between 10 and 25%.

Photographic Sound for 8mm Film

By JOHN A. MAURER

Photographic soundtracks for 8mm motion pictures offer a major advantage in cost as compared with magnetic tracks in all applications that require large numbers of release prints. Contrary to the general belief, photographic soundtracks can give at least as good quality as magnetic sound stripes. A demonstration system using a Kodak 8mm Magnetic Sound Projector modified to reproduce photographic tracks is described, and performance data are given.

THAT SOUND would someday be added to 8mm motion pictures has always been a certainty. The step has been technically feasible for at least the past ten years. It was also predictable that in the beginning the soundtrack would be magnetic, since this is the only method of sound recording that is well suited to the needs of the amateur, who is today the principal user of 8mm film.

It has already become obvious, however, that 8mm motion pictures with sound can be useful in many new ways in industry and in education. It is clear that 8mm film will become more and more a professional medium, and that many copies of most film subjects will be required. Other participants in this symposium have expressed the conviction that the medium holds revolutionary possibilities, largely because they expect that prints will be made available in very large numbers at moderate cost. In meeting this need the added cost of the magnetic soundtrack may well be a serious handicap.

The purpose of this paper is to urge as forcefully as possible that we take a realistic look at the comparative advantages of photographic (or "optical") sound and magnetic sound for 8mm film before the nontheatrical industry has committed itself completely to one of these methods.

Photographic vs. Magnetic Sound for 8mm Film

To make a photographic soundtrack, we use the light-sensitive emulsion that is already on the film, and we process it in the same solutions that are already necessary for the picture. Printing the picture and sound in one pass through the printer is not merely feasible, it leads to the most economical way of building the equipment and the most convenient way of working. The soundtrack produced in this way adds very little to the cost of a silent picture print. Adding the magnetic track requires two more operations — striping, and rerecording the sound. Even when these operations are carried on in multiple on 32mm or 35mm film, they add substantially to the cost of the print.

As will be shown later, the cost of producing an 8mm print with photographic sound, with either black-and-white or color film, can be reduced to the order of one-fourth of the cost of producing an equivalent 16mm print of the same subject. The writer believes that it is necessary to reach this level of cost in order to open the fields of usefulness that are within the possibilities of 8mm film.

The Impossibility Concept

The principal difficulty, of course, is that "*it cannot be done*" or "*it can be done only under advanced scientific laboratory conditions.*"

Since these statements probably express the opinions of the overwhelming majority of workers in the film industry, and since what is at stake may well be nothing less than the healthy development or nondevelopment of an important new industry, the writer feels that it is unavoidably necessary, at this time, to analyze rather fully the inferiority complex that has dominated the thinking of the sound-on-film industry for the past thirty years.

Frequencies and Speed

The histories of photographic sound recording and magnetic sound recording present an interesting lack of parallelism. The first magnetic recorders to reach the American market after World War II operated at a linear tape speed of 30 in./sec. Today we have tape recorders for home use which record and reproduce 10,000 to 14,000 cycles at a tape speed of $3\frac{3}{4}$ in./sec. Photographic recording began about 1927 with a linear film speed of 18 in./sec and a recorded frequency range of 6000 cycles. In the early 1930's the frequency range was extended to between 7000 and 8000 cycles, and was standardized. The standard has remained the same ever since. Sixteen-millimeter sound, originally regarded as impossible, is to this day limited to a low standard of fidelity by the characteristics of available reproducers, although it has a linear speed of 7.2 in./sec. Eight-millimeter photographic sound, at a linear speed of 3.6 in./sec, is, for most workers, unthinkable. Yet the resolving power and uniformity of granule distribution of fine-grain photographic film are not inferior to those of magnetic tape. Why is it that the possibilities of photographic recording have remained largely unexplored for over thirty years?

Figure 1 is presented as evidence that it is not impossible to record high frequencies on film, even at a linear speed of 3.6 in./sec. It is equally possible to reproduce them.

Width of Light Beam

To succeed in any task, we must use the appropriate tools. In the process of reducing the linear speed of magnetic tapes from 30 in./sec to $3\frac{3}{4}$, and even to $1\frac{7}{8}$ in./sec, the magnetic recording industry has progressively reduced the gap in the reproducing head to as little as 0.0001 in. The consequences of similarly reducing the widths of recording and reproducing light beams have never been fully explored by the photographic industry, partly because premature standardization of the overall reproducer characteristics made it impossible to experience much benefit from such optical improvements. Of course, other questions, such as noise and distortion, are involved. We shall come to them before we have finished.

Figure 2, which is based on measurements made in 1950, gives a good picture of the relation between the width of the recording light beam and the frequency response of photographic recording. All these tests were made at a linear speed of 7.2 in./sec, on 16mm film, but they have been replotted to show their significance in terms of 35mm, 16mm and 8mm recording. In every case it is assumed that the record is scanned by a light beam of the width that is generally considered appropriate for the linear speed involved, that is, 0.0012 in. for the 35mm record, 0.0005 in. for the 16mm record and correspondingly 0.00025 in. for the 8mm record. The importance of the reproducing beam width attenuation should not be overlooked. In each of these cases it amounts to approximately 2 db at 5000 cycles, 4 db at 7000 cycles and 9 db at 10,000 cycles. Obviously one way of extending the frequency range would be to use narrower scanning beams.

The curves in Fig. 2 show the characteristics of constant-amplitude variable-area records with playback of the original record, not a print. No high-frequency pre-emphasis, such as is always used in practical recording, is included. For this the reader should compare Fig. 2(C) with Fig. 6. The

Presented on May 9, 1961, at the Society's Convention in Toronto by John A. Maurer, JM Developments, Inc., 116-118 West 29 St., New York 1.
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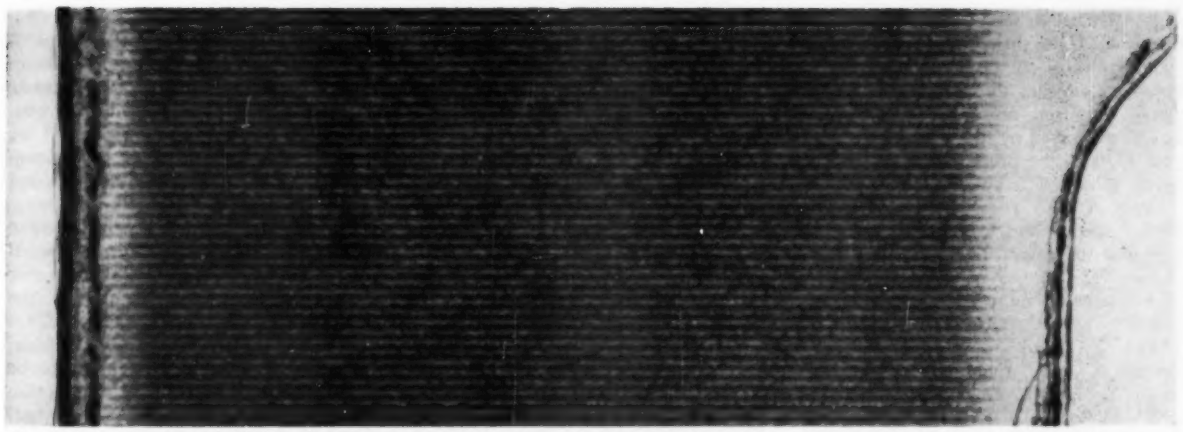

Fig. 1. Photomicrograph (180X) of 10,000-cycle record on 8mm film at 3.6 in./sec. Note corner of perforation at righthand side.

curves are applicable with little error to variable-density recording.

The recording optical system used in making these tests originally gave an image width of 0.00012 in. The wider images were obtained by changing a slit in the system. The widths stated are actual, taking into account all factors such as lens aberrations and diffraction. The film was normal black-and-white positive. Subsequent work has proved that these curves are reasonably representative of what can be accomplished by recording on color stocks such as Eastman Reversal Color Print Film, Type 5269, and Color Print Film, Type 7382.

With the information contained in Fig. 2 it is possible to understand both what *can* be done and the reasons behind the refusal of the industry to believe that wide-frequency ranges can be recorded successfully on film.

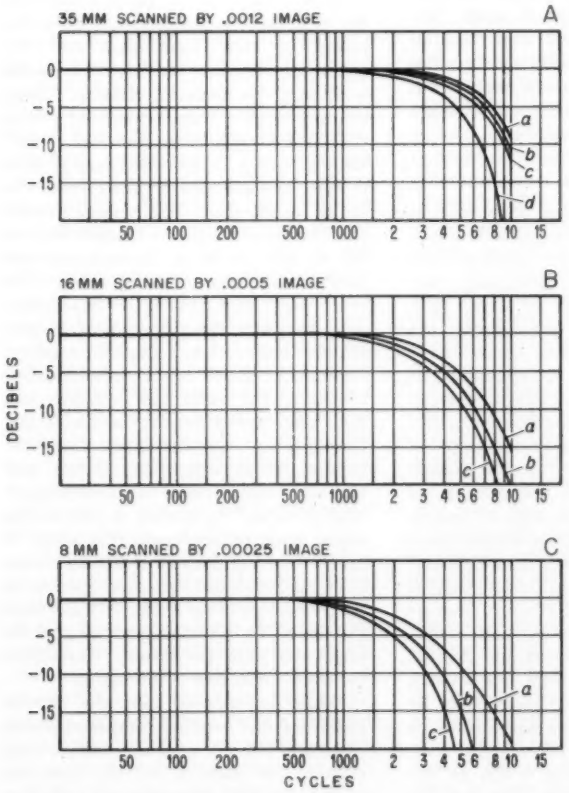

Fig. 2. Effect of the width of the light beam used for recording on the frequency response of photographic sound records (constant-amplitude recording) on 35mm, 16mm and 8mm film. Curves: (*a*) 0.00012-in. light beam; (*b*) 0.00025-in. light beam; (*c*) 0.0005-in. light beam; and (*d*) 0.001-in. light beam.

Neglect of Optics

Optics, unfortunately, is a branch of science that has been left out of the training of engineers for many years. What is contained in the usual college textbook of physics is scarcely the *ABC* of the subject. Unless he has a special interest in optics, the student learns no more than this. It is not surprising, therefore, that the men who were engaged in developing the first commercial sound-on-film recorders in 1927 and 1928, all of them good electrical or mechanical engineers, produced some rather shockingly bad designs in their optical systems.

As Fig. 2(A) shows, for 35mm recording it is desirable to have an image width not greater than 0.0005 in., although passable results can be obtained with a width of 0.001 in. The optical systems of 1928 were intended to give images 0.001 in. wide, but the means provided for focusing them were so imperfect that the effective image width, in almost every case, was nearer 0.002 than 0.001 in. An enlargement of a representative 5000-cycle record on 35mm film made with one of these optical systems in 1929 is shown in Fig. 3.

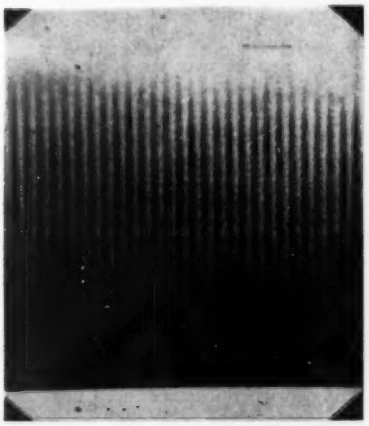

Fig. 3. A representative 5000-cycle negative on 35mm film made early in 1929.

It is not hard to see why workers were discouraged with this sort of result.

The work of all the early equipment designers appears to have been about equally bad from an optical standpoint, as was evidenced by the fact that in the year 1929 all the productions that were being exhibited in the motion-picture theaters of New York were plagued by lisping speech and other effects characteristic of poor high-frequency response. The causes of this deficiency were corrected only gradually over a period of several years, because it was almost universally assumed that the limitation was in the film rather than in the equipment. Only a few workers ever realized fully that the principal trouble was the failure of the recording optical system to form a sufficiently narrow line of light on the film. Thus it became established as a "fact" that it is very difficult to record high frequencies on film.

The persistence of this misconception is surprising. Thus in 1949 Frayne and Wolfe wrote: "Although the basic problems of recording on 16mm film are essentially the same as those encountered in the use of 35mm film, the lower film speed of the 16mm presents an entirely new set of problems. . . . Since the losses at 12,000 cycles on 35mm usually limit useful recording to that upper limit, it is quite obvious that a practical 5000 cycle upper limit on 16mm is indicated."

The reader should note the implicit assumption that it is impossible to record high frequencies at any closer spacing on the film than is being done by the existing 35mm equipment.

As part of this discussion Frayne and Wolfe published a curve (Fig. 28-6 of their book) which agrees well with curve *c* of Fig. 2(B) above, provided representative printing losses are added. This in effect proves that their tests were made with a standard optical system intended for 35mm recording, which at that time gave a 0.0005-in. image. Sixteen-millimeter recorders which had a recording image width of 0.00015 in. had then been on the market and widely used for over ten years, but the standard of performance that was thereby made possible could not be realized in practice because all 16mm sound projectors, in accordance with the prevailing concept of what was possible, were made to reproduce only about a 5000-cycle frequency range.

In short, it should be realized that recording equipment can be built, and, in fact, has been built by all the principal manufacturers, that is capable of much better quality than is being obtained at the present time, and the reasons for this poor performance are, first, the persistence of the belief that wide-range recording cannot be done photographically, and second, the lack of suitable reproducing equipment.

Other Limiting Factors

It should be added that four other factors have influenced the industry in its decision not to attempt to produce high-fidelity sound. These are the effects of contact printing, film background noise, cross-modulation distortion, and distortions arising from the conditions under which sound for motion pictures often must be recorded and from the many re-recordings that are sometimes needed to arrive at the effects desired. The set of problems last mentioned does not concern us here, since we are not discussing how to make 8mm sound better than 35mm sound, but the other problems deserve careful consideration.

Effects of Contact Printing

Contact printing of soundtracks with average equipment introduces losses of high frequencies that are about equal to the difference between curve *a* and curve *c* in Fig. 2. These losses obviously are of little importance in 35mm practice; they are serious limitations in 16mm work, and they would be fatal in 8mm. In addition to this, the negative in contact printing contributes most of the noise that is heard when the print is reproduced, since every random inequality of light transmission in the negative is magnified in the print by the high gamma of the print stock. For these reasons we cannot now think of printing 8mm sound from an 8mm negative. As film emulsions continue to improve this may well become possible at some time in the future.

Film Background Noise

Film background noise in general is due to three causes: the grain structure of the emulsion, dirt in the forms of scum and dust picked up in processing, and mechanical abrasions of all kinds. Film laboratory practices in the industry being as they are, very few workers have had the opportunity to evaluate the importance of these factors separately. More than twenty years ago the writer had to make a serious investigation of the possibilities of very narrow soundtracks on film, and for this purpose he found it necessary to arrange to process the films under quite exceptionally clean conditions. When this was done he found that tracks only 0.010 in. wide, running at a linear speed of 45 ft/min, gave no more noise in reproduction than standard 35mm tracks processed and printed under the usual conditions. As a result of this work and other experiences he feels that it can be stated with assurance that the granularity of modern films used for release printing is not an important source of noise. Dirt can be avoided by the proper use of water filters and air filters. Mechanical abrasions can occur, of course, in either processing or projection, but in both cases they can be avoided by proper equipment design. In the projector which was modified to demonstrate our photographic 8mm soundtracks we made sure that all parts that might have come in contact with the soundtrack were undercut, and we have noted no increase of noise from frequent projection of our experimental films.

Since the audibility of film background noise increases rapidly as the reproduced frequency range is widened, noise may be a valid reason for limitation of the range. We have used a range of 7000 cycles for our experimental 8mm films, and believe that this will prove to be desirable for commercial use.

Cross-Modulation Distortion

Cross-modulation distortion deserves much more attention than it is possible to give here. A paper on the subject is being prepared which the writer hopes to have ready in the near future. Certain facts are of such pertinence to 8mm, however, that they will be stated even though they cannot be documented fully. These facts are not unknown to at least some others in the industry.

Variable-area records as they are made and printed at the present time contain a substantial amount of distortion of the cross-modulation type which is not corrected and cannot be corrected by the generally accepted techniques for measuring cross modulation and determining the print density to be used with a given negative density. These techniques have been devised to correct the well-known distortion of "ess" sounds, which is so objectionable that it must be corrected if prints are to be at all acceptable. The residual cross-modulation distortion is in the range of 500 to 3000 cycles in 16mm prints and in the range from 1000 to about 4000 cycles in 35mm prints. Its correction, with the film types now used, would require either much higher negative densities or much lower print densities than are now used, and in either case the "ess" sounds would be badly distorted. This cross-modulation distortion in the middle frequencies is not particularly objectionable in the reproduction of music. In speech it produces a vague sense of unpleasantness which is immediately noticeable if a film record is compared with the same speech on magnetic tape or on a disc. In some cases the distortion is bad enough to give the impression that the speaker was suffering from a mild case of laryngitis.

While it appears that the precise nature of this residual cross-modulation distortion has not generally been recognized — at least, it has not been described in the literature — all film workers who are concerned about the quality of recording have recognized for a long time that film records were far less free from distortion than tape

and disc records, and since in general the proper procedure in reproducing a distorted record is to limit the frequency range, this has provided another reason for retaining the limited ranges that are used, especially in reproducing 16mm film.

It happens, however, that this is not the usual situation. The distortion products that are generated by cross modulation are mostly lower in frequency than the signals upon which they are superimposed, so that they are not rendered less, but rather more audible by supressing the high-frequency range. It is for this reason that 16mm records, for example, sound better on a projector that gives good high-frequency reproduction, such as the Eastman Model 25, whereas, being somewhat badly distorted, they should, by all the usual rules, sound worse than they do when reproduced on the usual projector with a rapid cutoff above 4500 cycles.

The type of cross-modulation distortion referred to above as "residual" cross modulation is not impossible to remove. It arises from the practice followed at present of using for the sound negative a film which has image spread characteristics that are decidedly different from those of the release print film. The film used for the sound negative exhibits a large "Ross effect"; that is, images on it contract in development because the gelatin is locally hardened by the reduction products of the metol and hydroquinone used in the bath. The release print stock exhibits much less of this effect because the emulsion has been prehardened. The shrinkage of the image on the negative affects the middle frequencies most. Large images are too firmly anchored to the base to change much in size; on the other hand, the high-frequency images are too small to shrink much in comparison with the spreading of the image caused by the irradiation of the exposing light in the emulsion. Since the middle frequencies do not contract on the *print*, we have the situation that when the image spreads are balanced for the higher frequencies, as they must be to prevent "ess" distortion, they are badly out of balance over the middle frequency range.

The remedy for this is to make the sound negative on film that has the same characteristics as the print stock in terms of the Ross effect. Some workers who have made the sound negative on standard release print stock have noted a substantial improvement in results, although this practice usually presents difficulties because the speed of the film is insufficient for most recorders.

These facts regarding cross-modulation distortion are pertinent in relation to 8mm sound for two reasons, first, because they show that another of the supposed obstacles to extension of the frequency range in photographic recording can be removed at any time that we choose to do so, and second, because they indicate a pitfall to be avoided in producing 8mm sound prints. The writer has no doubt that good 8mm soundtracks can be made by optical reduction from larger negatives, but in order to do so it will be necessary to record and process the negatives specifically for the optical reduction printing process. The situation that has existed for many years, in which 16mm optical reduction prints were made from the same negatives that were recorded for 35mm contact printing, simply will not do in the case of 8mm.

Re-Recorded Sound for Release Prints

We have preferred to work with variable-density tracks made by re-recording from magnetic master records because this procedure avoids all the problems associated with printing and with cross-modulation distortion and at the same time it gives a large measure of flexibility in other ways. The re-recording printer uses a mirror galvanometer with an optical system in which a mask, in combination with a narrow aperture on which the mask is imaged by a lens associated with the galvanometer, produces variable-intensity modulation of the light in the line image focused on the film. If the mask has the shape of a "V" with straight sides, the modulation is strictly linear. If the mask is modified to a shape somewhat like the profile of a bell, the modulation is made nonlinear in such a way that the nonlinear relation between exposure and resultant light transmission of the film can be compensated. With care one can obtain a strictly linear relation between electrical input to the galvanometer and the light transmission of the processed film over the entire range from the highest light transmission of which the film in question is capable, to, at the other extreme, a light transmission of about 3%. When the track is fully modulated between these extremes, the level in reproduction is as high as the level obtainable from variable-area tracks. This type of soundtrack is inherently free from the "ess" type of distortion; it gives pleasing and natural reproduction of speech; and the linearity attained is such that records of music are excellent.

A more detailed description of this method of recording will be found in the last paper in the bibliography.

It should be added that no new phenomena have been observed in applying the method to 8mm film; the fact that the waves of the record are five times as closely packed as in 35mm does not seem to have altered the basic characteristics of the recording process. Likewise we have observed no harmful effects from the proximity of the perforations.

For these 8mm tests an optical system originally designed for 16mm recording with an image width of 0.00015 in. was modified to give an image width between 0.00009 and 0.0001 in. At first we found it necessary to work with 16mm single-perforated film because no film with 8mm perforations was available which did not have manufacturers' tradenames or coded information printed in the space between the perforations and the edges of the film. Using a 16mm recorder modified by gear changes to run the film at a linear speed of 3.6 in./sec, and reproducing on a 16mm film phonograph similarly modified, we verified the fact that the color films on which most 8mm prints will presumably be made all yield satisfactory soundtracks. In this work we inserted a mask directly in front of the film in the reproducer to limit the width of the track reproduced to 0.020 in. Later we found a positive-type film made by Gevaert in Belgium on which the coded information is in the spaces between the perforations, and only occasionally encroaches on the area in which we have to place the sound track. With this we have made actual 8mm sound films which have been reproduced on a Kodak 8mm Sound Projector modified by removing the magnetic head and substituting a lamphouse equipped with a suitable scanning optical system and photocell, as shown in Figs. 4 and 5.

This optical system, which was designed specifically for this application, consists of three small cylindrical lenses, two of which are parallel to the lamp filament while the third has its axis at right angles to the others. The system in its mounting is 0.500 in. in diameter by 0.485 in. long; it is used with a 2-amp lamp, and produces a scanning image 0.00025 in. high and 0.020 in. long. The working relative aperture is somewhat higher than it is practical to use in 16mm scanning systems, since at this time it is reasonable to assume that it will be possible to standardize 8mm sound films in such a way that the problem of emulsion position, with the attendant problem of making an optical system that can be focused at the middle of the film base and be sufficiently well in focus at either surface, will not arise. Because of the use of the 2-amp lamp and this gain in relative aperture, the amount of light delivered to the photocell is comparable to the amount delivered in 16mm projectors which use the 0.75-amp lamp.

It was not possible to modify the amplifier originally used in this projector to record and reproduce magnetic sound, since it used a printed circuit. The amplifier which was substituted for it is entirely conventional. The photocell is the familiar type 927, used with a bias of 70 v. The cell itself introduces a

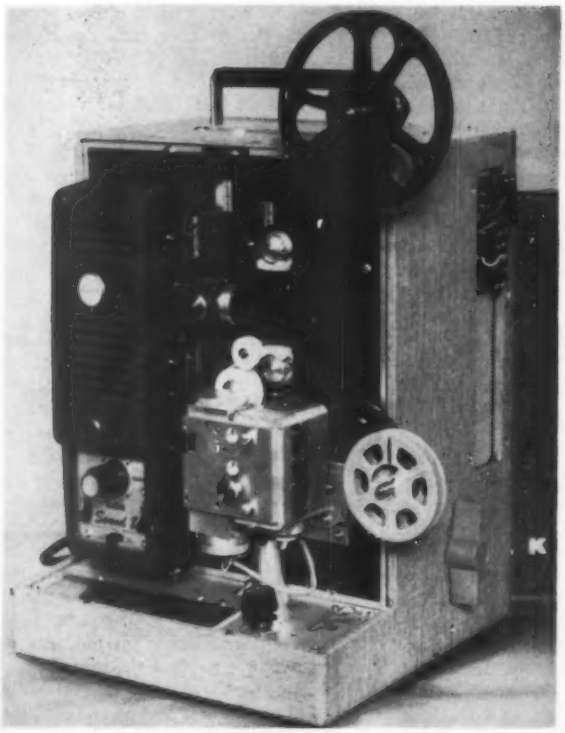

Fig. 4. 8mm projector modified to reproduce soundtracks 0.030 in. wide.

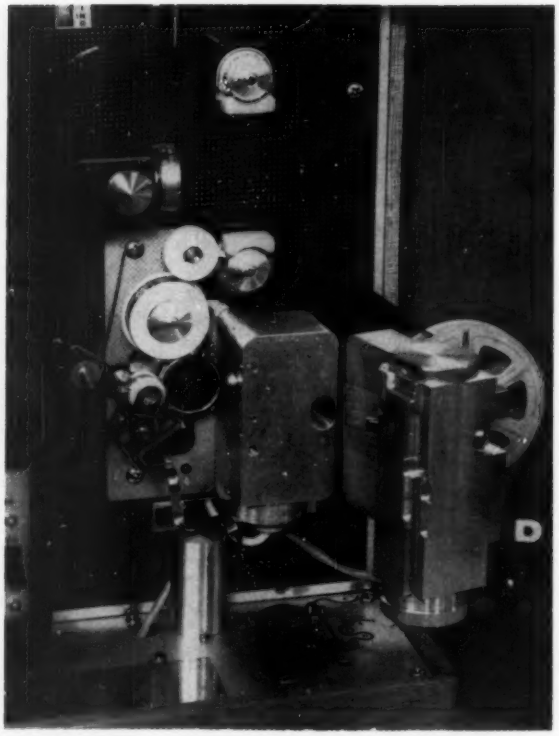

Fig. 5. Close-up showing lamphouse, reproducing optical system and photocell housing of modified projector.

drooping frequency characteristic which is easily compensated in the amplifier. We have made the system flat to 7000 cycles as tested by means of a device we have used for many years which gives constant modulated light in a beam similar to the one reaching the cell in a projector. This device was first employed to standardize the equipment used to calibrate the ASA Standard 16mm Multifrequency Test Films.

The overall playback frequency characteristic obtained with this projector, including high-frequency preemphasis in the recording amounting to a maximum of 8 db at 6000 cycles, is shown in Fig. 6.

It should be apparent, therefore, that no great problems are involved in producing an 8mm projector to reproduce photographic soundtracks.

Quantity Production

In the writer's opinion the best method of producing 8mm sound prints in quantity will be to use a continuous 16mm to 8mm picture reduction printer exposing two rows of picture images running in the same direction on specially perforated double 8mm stock. The two soundtracks can be re-recorded at the same time from a magnetic original. If the frequency range of the prints is, for the present, limited to 7000 cycles and if the light modulator is flat to 50,000 cycles, the printer can be operated at 6⅔ times projection speed, or 120 ft/min, and it will produce 240 ft/min of 8mm prints. Since this is equivalent to 480 ft of 16mm film, the printing cost will have been reduced to about one-fourth the cost of printing 16mm. The ratio of film stock cost between 16mm and 8mm is, of course, 4 to 1. The use of stock 16mm wide rather than 35 or 32mm wide will minimize errors due to slitting.

The necessary light modulators of wide-frequency range have been developed and have been in commercial use for the past year.

It is hardly possible to overemphasize the fact that this method of producing 8mm photographic soundtracks is *not* an extremely difficult achievement of the scientific laboratory. It is a comparatively simple technique which can be put into practice in any properly controlled *film* laboratory.

The soundtracks we have made for demonstration purposes have had substantially the same dimensions as the magnetic stripes for which the projector was designed. Figure 7 shows the film with the soundtrack and with the scanned area drawn in to scale and dimensioned in the usual way. On the basis of the tests made thus far, we consider this a practical system.

Proposed Change in Standard

We believe, however, that it would be advantageous to make a change in the direction shown in Fig. 8, which we have forwarded to the Sound Committee and the 16mm and 8mm Committee as a definite proposal for standardization. If the perforation on 8mm film, which is now 0.050 in. high and 0.072 in. wide, were changed to a square perforation, 0.050 in. in each direction, keeping the side next to the picture in the same position as it is at the present time, we would have a space 0.058 in. wide between the other side of the perforations and the adjacent edge of the film. In this space it would be possible to record a variable-density soundtrack 0.050 in. wide without permitting light to strike either the edges of the perforations or the narrow, ragged edge resulting from the slitting of the film. (Light striking either of these edges may be scattered into the body of the track in a way that produces noise in reproduction.) Of this 0.050-in. track it would be possible to scan a width of 0.040 in. while allowing a generous tolerance for the guiding of the film at the sound reproducing point in the projector.

A change of the standard in the direction shown in Fig. 8 and described in the above paragraph would obviously facilitate the production of 8mm sound films with either photographic or magnetic track. It would have the further consequence that 8mm sound prints probably would not run satisfactorily on existing *silent* projectors. All silent prints, however, would run without difficulty on sound projectors made for

this standard. The writer believes that this is as great a degree of interchangeability as is needed.

The proposed change of standard would make it possible ultimately to provide stereophonic sound for 8mm pictures, which would be difficult with a space no wider than 0.036 in. available for the two tracks.

On the basis of many years of experience and many dealings with users of nontheatrical motion pictures the writer hopes that he will be permitted the following general observations. Let us by no means repeat in 8mm the mistake that was made in the beginning with 16mm, of establishing a mediocre standard of performance for which the industry has had to be apologetic then and ever since. With either magnetic or photographic sound it is easily possible, by making use of the many technological advances of the past twenty years, to provide a substantially higher standard of performance both in 8mm soundtracks and in projectors which can be sold at reasonable prices. The improvement in intelligibility and naturalness of sound by going from a 5000-cycle frequency range to a 7000-cycle range is enormous. Not to do this in a time when high-fidelity sound is available everywhere by FM radio, tape recorders, and on vinylite discs would be shortsighted in the extreme.

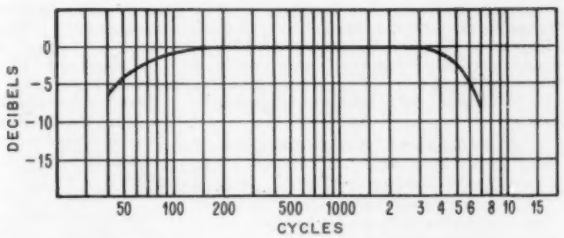

Fig. 6. Overall playback frequency characteristic of experimental 8mm photographic records.

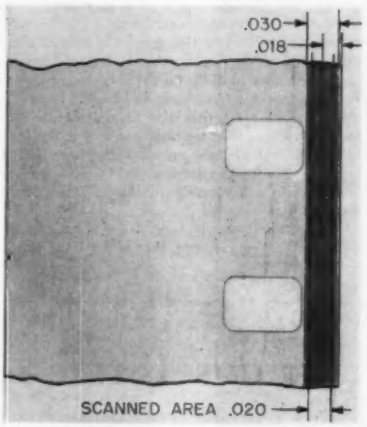

Fig. 7. Photographic enlargement of a section of 8mm film showing the track; dimensions in inches.

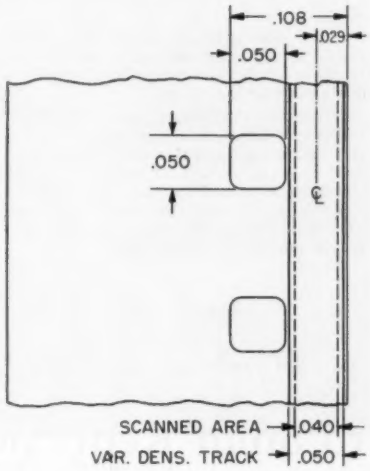

Fig. 8. Scale drawing of the proposed new standard involving a perforation 0.050 in. high and 0.050 in. wide instead of the present 0.050 by 0.072 in.

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Discussion

Robert Lovick (*Eastman Kodak Co., Rochester, N.Y.*): You have referred to several things which are pretty close to the heart of some of the work that we have been doing, some of the things we'd hoped to report long before this — in particular, the nonlinear recording and also modulators going out into the vicinity of 50,000 cycles — strike very closely to the glow modulators which I think are being overlooked. I wondered if you'd care to give us any idea about how you managed to stabilize the nonlinearity. One of the problems that has faced us has been getting a stable, reproducible and controllable degree of nonlinearity. Do you use some losser circuits with varistors in the feedback path, or what?

Mr. Maurer: I don't know by what method you are producing nonlinearity. Our method gives a stable result because the nonlinearity is determined by the shape of an approximately "V" shaped mask in the optical system. If this mask had straight sides the modulation would have a strictly linear relation to the motion of the galvanometer mirror. Since this would not result in linear playback from the film, we give the mask a different shape which is determined by careful measurements of the characteristics of the type of film we wish to use, so that the overall result is made linear. As long as the galvanometer does not change its characteristics the type of nonlinear exposure given to the film will not change. We are fortunate in having a type of galvanometer that has extremely stable characteristics. Even the zero position is not affected by long periods of use or by large overloads.

Mr. Lovick: Your approach is quite different from ours — yours is mechanical where ours is electrical. I have another question — you mentioned the figure of 2½ ten-thousandths for the reproducing slit. Do you think it's possible to maintain this in a production type of operation? I'm sure it's difficult to do in the laboratory — I wonder how you'd envision producing good enough lenses at a low enough price to do this in actual 8mm projectors.

Mr. Maurer: I find it hard to understand why this is regarded as a difficult problem.

For many years we have been building optical systems in which we use small plano-cylindrical lenses, each of which is made by grinding away part of a piece of round glass rod and polishing the resulting flat surface. Glass rod obtainable for about eighty cents a pound from chemical supply houses will give radii down to 1.5 mm, and if shorter focal lengths are needed it is easy with the aid of a gas flame to draw rods starting from about 6-mm diameter down to diameters of 1 mm or even less. Anyone who has a little experience in glass blowing can readily produce hundreds of rods that have uniform diameter over lengths of several inches, and with a little practice it is easy to get the desired diameter most of the time. A small block of brass milled with channels into which the glass rods are cemented with blocking pitch will hold enough pieces to yield, after grinding and polishing, over a hundred lenses of the size needed for this type of optical system.

It is not necessary to work blindly. It is easy to test the glass rods for optical perfection of the cylindrical surfaces before blocking them for grinding. More than 50% of all small glass rods will be found to be of satisfactory quality.

It seems to me that it would be extremely easy to organize this as a large-scale operation to produce, if necessary, hundreds of thousands of the small cylindrical lenses needed for this type of optical system.

The optical system we have made uses one lens which is a complete glass cylinder — a short piece of glass rod. This system produces the 2½ ten-thousandths inch image on the principle of the compound microscope — one lens forms a reduced image of the lamp filament and a second lens then forms a further reduced image of that image. We are not yet too close to the limit of smallness set by diffraction; therefore the design of the system is only a matter of routine optical computation.

Mounts for the lenses for quantity production of optical systems can be made with quite sufficient accuracy by plastic moulding or by coining small metal parts. What will be most important in practice will be to provide suitable means for adjusting the optical systems by the use of test films during the assembly of the projectors, and for locking them securely in position after they have been set for focus and azimuth.

Ellis W. D'Arcy (*Gary, Ind.*): Do I understand correctly that there were no turbulation effects caused by the processing either in the soundtrack or in the sprocket perforations?

Mr. Maurer: We haven't observed any, so far. We have had test tracks processed both on

commercial machinery and in our own crude rack-and-tank system. Specifically, we've had film processed by Eastman, which I believe is not a spray method; we've had it processed in a laboratory where they did use a spray machine, and we've processed it ourselves in rack-and-tank.

David W. Ridgeway (*Chemical Education Material Study, Harvey Mudd College, Claremont, Calif.*): Where does the track go on the 8mm?

Mr. Maurer: As will be clear from the longer version of this paper, prepared for publication, the track has been placed in the same location as the magnetic track, between the perforations and the edge of the film. The recorded track is thirty thousandths of an inch wide, and we scan a width of twenty thousandths down the center of it.

Fred Aufhauser (*Vicom, Inc., Rochester, N.Y.*): Could you give us some idea of the cost involved in converting, both on the laboratory level and on the projector level?

Mr. Maurer: The cost to equip a laboratory will be less than for magnetic 8mm unless we assume that someone will prestripe all the release print stock for the industry. If this were done the costs of printing equipment for photographic and for magnetic sound would be about equal. As I stated in the paper, the operating cost for photographic sound would be much less.

I believe experience in the 16mm field has demonstrated that manufacturing a projector to reproduce magnetic sound is not any simpler than manufacturing an optical reproducer. The optical reproducing system has two advantages. Once the optical unit has been locked securely in position it will not wear out or change, because the track does not rub against it. For the same reason it is easier to get good constancy of film motion in an optical reproducer.

George Lewin (*Army Pictorial Center, Long Island City, N.Y.*): Are you necessarily ruling out the possibility of duplicating the soundtrack by reduction or contact printing rather than re-recording?

Mr. Maurer: No, not at all. In the longer version of this paper I have discussed the problems of optical reduction at some length. I believe that optical reduction can be an entirely satisfactory procedure if the proper conditions are satisfied. As for contact printing, I would not say that at no time in the future will contact printing be a satisfactory method in 8mm. It is my opinion, however, that the film we have seen today indicates that we ought to stay away from contact printing at the present time, because it is important to get the 8mm sound industry started with the highest possible quality in both picture and sound.

I feel very strongly, and I know that many educators agree with me, that the 16mm industry has realized only a small fraction of its potential through the years because it has never really tried to deliver high-quality picture and sound. Mediocrity of performance is not necessarily recognized as such by the nontechnical audience, but nevertheless a state of fatigue results when the picture is not sharp and when sound has a muffled quality or is on the border line of being unintelligible. This leaves everyone with little enthusiasm for repeating the experience. The quality of a great deal of 16mm film and equipment in use today is such that it will not be very difficult to surpass it in 8mm. I think the 8mm industry ought consciously to try to do so.

Louis Forsdale (*Teachers College, Columbia University, New York*): I said in another meeting today that many educators might be attracted to the flexibility of magnetic tracks on 8mm. I should urge you engineers, however, to make your choice between optical and magnetic sound not on that assumption, but in the final analysis on cost. Educators will favor the cheaper medium that will permit greater de-centralization of libraries.

Mr. Lewin: I should make a personal announcement in that my paper tomorrow will demonstrate how we can have both optical and magnetic on the same film. I have great hopes we can do that on 8mm as well as on 16mm.

A High-Speed Continuous 16mm to 8mm Reduction Printer

By KENNETH B. CURTIS and WILLIAM D. HEDDEN

Optimum quality 8mm release prints usually are obtained by direct reduction from 16mm negatives. Most 8mm reduction printers are of the step type, operating at relatively slow speeds. This paper describes a continuous 8mm optical printer running at 250 ft/min. Quality advantages of reduction printing are combined with production advantages of continuous printing. Sprockets on a common driveshaft and a U-shaped optical system are used.

With the advent of a number of 8mm sound projectors recently, much speculation has been given to various methods of making 8mm release prints. Very few laboratories owned, or even contemplated, equipment designed for single 8mm printing or processing. Those who did plan to make 8mm release prints generally desired to utilize their existing 16mm or 35mm facilities. By making multiple 8mm prints side by side on these wider 16mm or 35/32mm films, 8mm prints could then be separated into individual rolls by slitting. Our own laboratory primarily uses 16mm equipment. We were interested in using this 16mm equipment for 8mm release printing. This paper, therefore, relates to 16mm equipment and materials rather than to 35/32 methods.

Since double-width 8mm prints were intended, it seemed desirable that they be contact printed from similar double-width 8mm negatives. Prints could then be made on existing high-speed 16mm contact release printers. This would seem to be a highly efficient method of mass production of 8mm prints. Unfortunately, it was found that prints made in this manner by contact printing from double-width 8mm negatives had serious quality loss.

This quality loss appeared to be related either to the usual contact problems in high-speed continuous printing or the greater resolution required for 8mm materials. Although this contact problem probably is present in 16mm printing, it is not noticeable in 16mm prints. With the smaller 8mm prints the same situation probably leads to a loss of sharpness that is objectionable. Improvements to obtain better contact in 16mm generally resulted in Newton's rings rather than picture improvement.

For a number of years 8mm prints of good quality were made by reducing 16mm optically to the 8mm size. This optical reduction step eliminated the contact loss problem and improved the quality considerably over that obtainable with the double-width 8mm contact printing method. Optical printing was by the step method, however, and generally at very slow printer speeds, achieving a good quality but too low a production rate for large-quantity release printing.

To utilize the good features of each method, a continuous high-speed optical reduction printer was designed and constructed. With such a printer the high-picture quality of optical reduction was combined with the high productivity of the faster continuous-type printers. The printer described here (Figs. 1 and 2) has been in operation on production with satisfactory results.

Two primary requirements were considered when designing the printer. Mechanically, its film transport system must achieve the ultimate in print steadiness. Optically, the lens systems used to effect the image reduction must be of very high quality. The basic design finally chosen was to drive both the 16mm and the 8mm film on a common shaft. A U-shaped optical system was then utilized for the reduction. (See Figs. 3–5.)

Probably the most important characteristic of the film transport system was the sprockets moving the film. Much effort and previous design experience were utilized in achieving the high degree of mechanical accuracy desired in the sprockets. After various popular indexing methods were considered, a unique principle of optical registration

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Presented on May 11, 1961, at the Society's Convention in Toronto by Kenneth B. Curtis and William D. Hedden (who read the paper), Calvin Productions Inc., 1105 Truman Rd., Kansas City 6, Mo.

(This paper was first received on April 3, 1961, and in final form on June 19, 1961.)

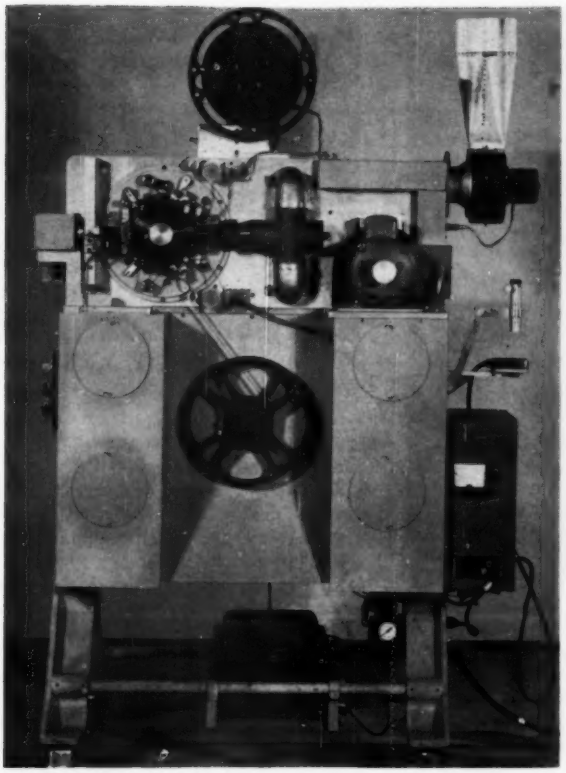

Fig. 1. The 16mm side of printer, threaded.

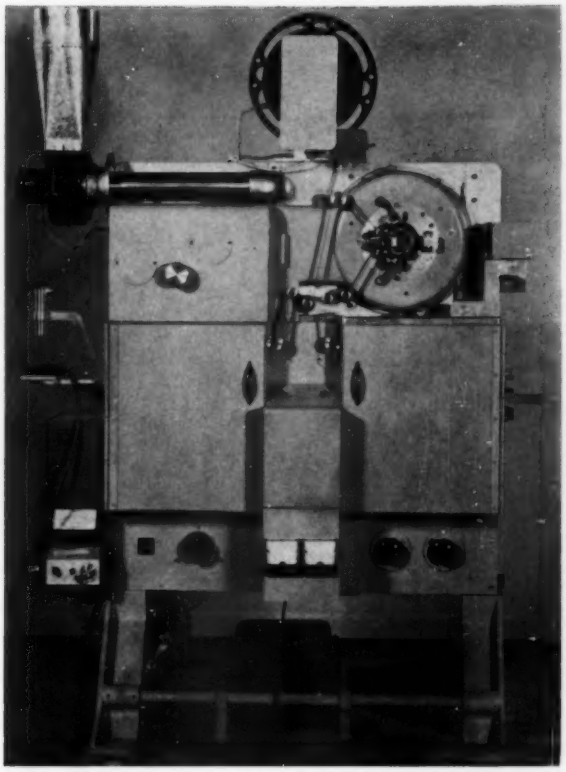

Fig. 2. The 8mm (opposite) side of printer.

was used in sprocket construction. The machining of these sprockets was done on a horizontal milling machine with form ground roughing and finishing fly cutters.

The sprockets are of 60 teeth each. They are figured for 0.5% film shrinkage for a seven-tooth engagement.* Since each sprocket has only one film on it, more wrap is possible than is normally used. The 8mm raw stock, for instance, travels in direct mesh with its sprocket teeth and against the smooth periphery of the sprocket body through an angle of 282° (Fig. 6). This obviously holds the film quite steady as it passes the printing gate. The 8mm sprocket has teeth to engage perforations on both sides of the film. The teeth in the row adjoining the area to be printed are of full width, though the teeth on both sides are matched for profile and thickness.

Flanges of all auxiliary rollers contacting either sprocket are greater than film width by at least 0.005 in. to avoid conflict in guiding the film on full-width teeth. Retractable auxiliary rollers feed the film on and off the 8mm sprocket.

On the 16mm side there is but one set of sprocket teeth (Fig. 7). A free-wheeling companion rail on the side of the film opposite to the sprocket is equal to the base diameter of the sprocket and serves as a supporting shoulder for the side of the 16mm film not being driven.

The 16mm head design was adapted from our 16mm Colormatic printer

*"Recommendations for 16mm and 8mm sprocket design," *Jour. SMPTE, 54:* 219–228, Feb. 1950.

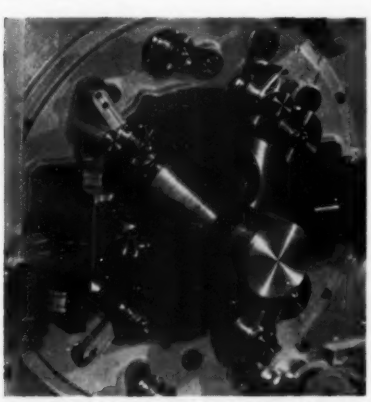

Fig. 3. The 16mm printing head showing guide rollers and gate aperture.

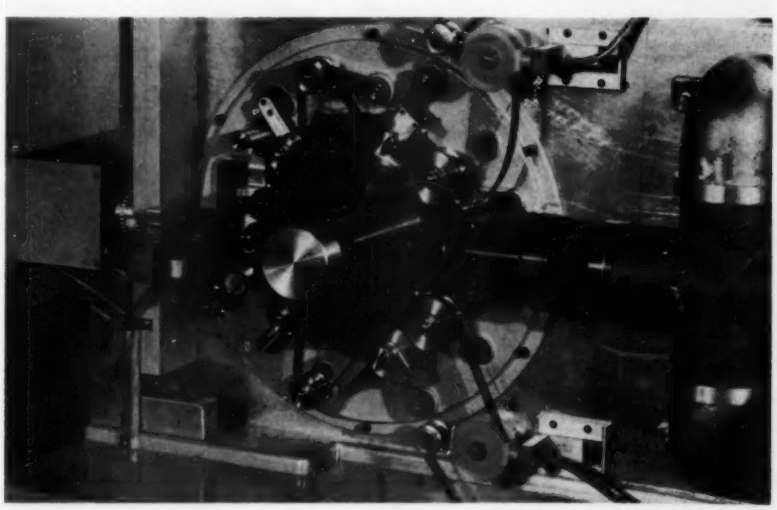

Fig. 4. The 16mm printing head showing (right) lamphouse, (center) film drive, and (left) optical system and lens.

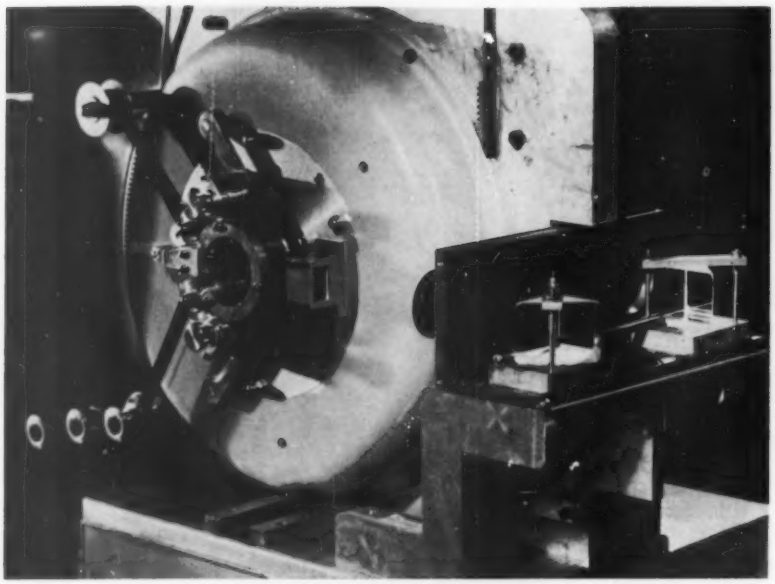

Fig. 5. U-shaped optical system, showing prisms and 8mm sprocket.

head.† A film speed of 250 ft/min on the 16mm side is achieved for continuous printing.

On the 16mm side a hinged shoe of two flangeless rollers and a demountable $\frac{3}{16}$-in. slit aperture plate face the optical system. The film wrap on the 16mm side is considerably less than on the 8mm side because of the possibility of shrinkage variability in printing negatives. The 16mm negative film is still held fast to the sprocket as it passes the printing gate. This is accomplished by two stationary rollers spaced slightly out from the sprocket for threading clearance. Consequently, the film is not forced to mesh with the teeth. Film damage has been practically nonexistent.

On the 8mm side there really is no printing aperture as the reduced 16mm aperture image is formed on one side of the 8mm print film. A single aperture in the sprocket body — larger by 0.005 in. than the total 8mm frame size — provides a rear-view inspection through a right-angle prism. A demountable $7\frac{1}{2}\times$ power glass enlarges the image for inspection or focus. An automatic dowser protects the 8mm raw stock against flare onto the 8mm adjacent print side should no 16mm film be in the 16mm gate.

Considerable trial and error went into the design of the U-shaped optical system. While the principal requirement was sharpness in the image reduction, adequate illumination also had to be present for the exposure of 7383 Eastman Color print stock. A 1000-w projection bulb was used for the light source and 600 cu ft/min of air flow cools the bulb.

A 40mm *f*/1.6 Ektar camera lens projects the 16mm image through the U-shaped path made by two right-angle prisms. An *f*/2.8 103mm 1:1 Kodak printing Ektar lens reduces the return image onto one half of the double 8mm wide raw stock. There is sufficient exposure for 7383 Eastman Color print stock at about 90 v on the 1000-w lamp.

Several other interesting mechanical details may be mentioned. Timing belts are used in the drive which is powered with an Eaton Dynamatic fractional horsepower Adjusto-speed motor. This motor is equipped with a unique manually operated clutch for controlled machine acceleration. An adjustable brake is also used for controlled deceleration. Such controls safeguard against film breakage. Torque motors also drive all take-up and supply reels. Twelve-hundred-foot take-up stock

† Lloyd Thompson and Kenneth B. Curtis, "The Colormatic Printer," *Jour. SMPTE, 68:* 576–578, Sept. 1959.

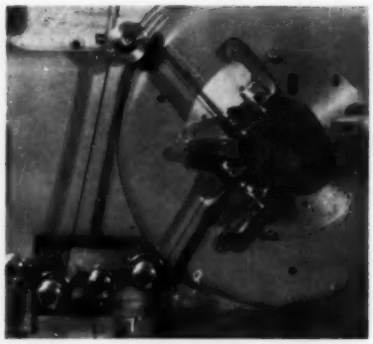

Fig. 6. The 8mm sprocket showing 282° film wrap and guide rollers.

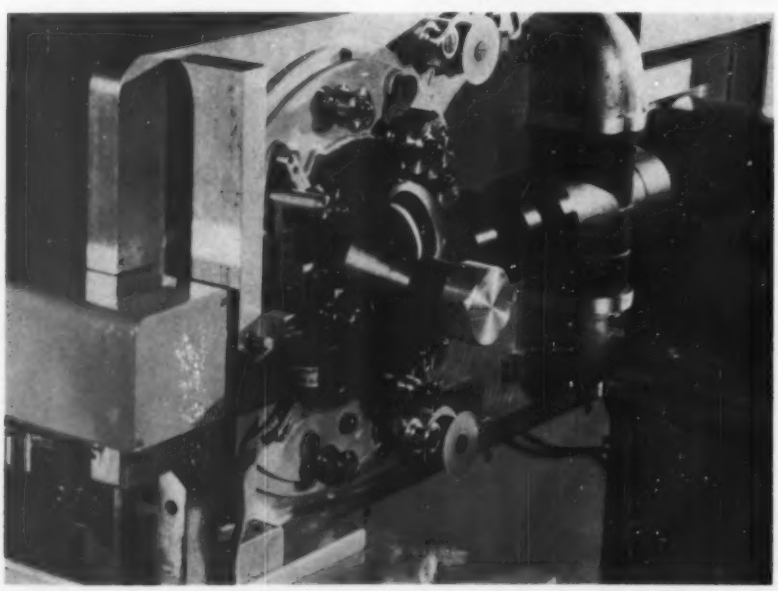

Fig. 7. The 16mm side showing motor, lamphouse, printing head, dowser and optical system.

Fig. 8. Densichron attached to 8mm head to monitor printing light exposure setting.

magazines are used. This permits the machine to be threaded in room light.

A Densichron unit is mounted into the machine (Fig. 8). This unit is used to monitor the light for printing exposure setting. A filter receptacle for correction filters is located in the 16mm head behind the film gate. A double filter holder containing two compartments is used. One compartment holds color correction filters and the second holds density filters for exposure balancing at constantly held voltages.

A proximity type cue mechanism automatically stops the printer at each end of the negative. Silver cue spots placed on each end of the negative actuate the printer stop mechanism to stop the printer before the negative is unthreaded. This allows the negative to stay threaded at the end of each print. As the printer in reversible, considerable threading time is saved as only the raw stock need be rethreaded.

The writers of this paper are greatly indebted to the late Lloyd Thompson. The basic philosophy and ideas behind this printer were largely gained through his untiring work in the development of 8mm uses and procedures.

Errata

April 1961

"Electron-Optical High-Speed Camera for the Investigation of Transient Processes," by V. S. Komelkov, Y. E. Nesterikhin and M. I. Pergament. pp. 275–279

On p. 276, col. 2, par. 5, line 6—*For:* 6ВІπ; *Read:* 6В1П
Fig. 3—At left: *For:* 6ВГП; *Read:* 6В1П
At right: *For:* ДГЖ; *Read:* Д2Ж
On p. 277, Fig. 4, and on p. 278, col. 1, par. 3, line 2, and thereafter
For: СφР; *Read:* SFR (СФР)
On p. 277, col. 1, par. 4, line 2, and thereafter
For: лйМ-3; *Read:* ПИМ-3
On p. 278, col. 2, par. 3, line 4—
For: 1.5×10^6 frames/sec; *Read:* 2.5×10^6 frames/sec
Table I—*For:* Рφ; *Read:* РФ
Fig. 8, Title—*For:* 10^{-7}/sec; *Read:* 10^{-7} sec (throughout)
On p. 279, col. 1, Eq. (1)—*For:* $E = \Pi B_o \ldots$; *Read:* $E = \pi B_o \ldots$
Col. 1, par. 2, line 15—*For:* lumen/watt; *Read:* candle/watt
Col. 2, par. 2, line 9—*For:* transparent support; *Read:* transparent conducting support

May 1961

Progress Committee Report for 1960, pp. 323–374:
Fig. 28, p. 332, was incorrectly titled. The equipment illustrated is the Florman & Babb Triplex Animation Stand.

Fig. 53, p. 349, equipment illustrated is a Nagra III Pilot-Tone portable synchronous sound recorder manufactured by Nagra-Kudelski Co., Lausanne, Switzerland. It is used by the National Film Board of Canada.

"A Method of Analyzing High-Speed Films," by Franz Topfer, pp. 374–376:
Footnote, p. 374, Correct address for author is 15, rue Sohet, Liège, Belgium. (Headquarters of Research Film Section, International Scientific Film Assn. is in Göttingen, Germany.)
On p. 374, Fig. 1, Title—
For: The film analyzer subsequently modified as described.
Read: Film analyzer.
On p. 375, col. 1., par. 1, line 3—
For: 100 pulses/sec
Read: 1000 pulses/sec

June 1961

"VFK-ÚVOJM High-Speed Framing Camera," By Jan Hampl, pp. 443–447:
On p. 443, Abstract, line 3—
For: 8000 to 42,000 frames/sec
Read: 6000 to 42,000 frames/sec
On p. 447, col. 2, par. 3, line 2—*For:* mirror M; *Read:* mirror B_1 and *For:* inner mirror M_2; *Read:* inner mirror B_2
New Products, p. 476, col. 2—
For: Cinephonic 22, an 8mm rear-view sound motion-picture projector
Read: Cinephonic 200 8mm Rear Screen Projector

July 1961

"Electronic Image Intensification: Image Intensifier Using Cathodo-Conductivity," by R. A. Chippendale and J. R. Folkes, pp. 527–532:

On p. 530, col. 1, par. 4, line 15—
For: (H_2O CO CO_2 O_2 Cl_2)
Read: (H_2O, CO, CO_2, O_2, Cl_2)

On p. 531, col. 1 par. 1, line 4—
For: . . . cathodes of 50 to 60 μamp/cm²
Read: . . . cathodes of 50 to 60 μamp/lm

CBS Television Standards Conversion Techniques

By K. BLAIR BENSON

The advent of video tape has provided a means for the rapid intercontinental exchange of television programs wherein the transmission delay need not exceed the travel time of modern jet aircraft. However, the difference in picture scanning parameters employed by various nations often prohibits broadcasting the video signal in its original form and necessitates a conversion to the appropriate transmission standards. Problems related to the design of converters for this purpose are discussed and the equipments used by CBS are described.

Introduction

Until very recently, the international exchange of television programs has been an insignificant part of broadcasting in America. The release of news and other special events of universal interest has been carried out for several years among European countries through the Eurovision network of coaxial cable and microwave interconnections. However, the lack of direct transatlantic connections has limited overseas participation to a time-delay release employing motion-picture film as the storage medium. Using regularly scheduled airlines and routine film laboratory processing, the delay has been at least a full day. Only by very special transportation arrangements and rapid processing of television film recordings has the overseas release been accomplished in the same day as the original telecast.

The advent of video-tape recording combined with the rapid expansion of fast, commercial jet aircraft transportation has changed the international television picture materially. In fact, it has created an entirely new type of programming activity. For example, now it is possible to record daytime European events on video tape and, without the need for costly and frequently time consuming processing, immediately whisk the recording by jet to America in time for evening transmission over nationwide United States and Canadian networks.

Necessity for Standard Conversion

However, this flexible and useful adjunct to television operations has not come about without accompanying technical complications, the foremost of which is the lack of a common standard for picture signal transmission throughout the world. The salient characteristics of the various standards affecting the conversion problem are tabulated in Table I. In the United States, television pictures composed of 525 lines are transmitted at a rate of one complete frame every $\frac{1}{30}$ sec. Although the European nations employ three different line standards, all transmit at the somewhat slower frame rate of one every $\frac{1}{25}$ sec. In England each frame is composed of 405 lines. France and parts of Belgium utilize a standard of 819 lines/frame. Other countries employ the CCIR standard of 625 lines/frame. Thus, it is necessary to reconstruct the video signals at the appropriate scanning rate before transmission at a different standard.

The problem is solved readily when television film recording or direct photography is the medium for interchange, since the video signal is recorded as a complete picture image at the standard international film rate of a nominal* 24 frames/sec. Playback at the required television transmission standard is accomplished by normal television telecine projection and camera equipment.

Video-tape recording, on the other hand, does not reconstruct the electronic signal in the form of an image. Instead, the playback video signal is essentially an exact replica of the recorded signal, with the same line and frame rates. Therefore, either before recording or after playback, a conversion of the video signal to the desired transmission standard must be performed.

Fundamental Problem of Standard Conversion

The conversion of video signals from one standard of transmission to another can be accomplished successfully through an optical transfer of the picture signal from a picture monitor to a television camera. The monitor operates on the standard of the original signal and the camera on the appropriate conversion standard. However, since the picture scanning rates of any two transmission standards are different, at only one instant in a given period will the electron beam of a converter input system be scanning the same spot of the raster as the beam of the output system. The period between times of coincidence of the two scanning systems may be several lines or several fields, depending upon the finite values of line and field scanning rates. Consequently, it is necessary to store information for periodically varying periods of time. In other words, between times at which coincidence occurs between the input and output scanning beams, video information must be stored until the output system scanning covers picture areas already passed over by the input system scanning.

Storage Requirements

As already noted, the European standards of 405, 625 and 819 lines all are transmitted at the field rate of 50 cps. Although the electron beam of the picture tube moves at a different horizontal rate in each of the three systems, in all, the scanning action progresses from the top to the bottom of the raster at the same rate. Consequently, if the field frequencies of the converter input and output signals are synchronous and in phase, storage is required only for the duration of a few lines. The only fundamental loss of resolution from the conversion process occurs in the vertical direction and results from lack of coincidence of the input and output signal scanning lines. Partial coincidence occurs only periodically.

This degree of storage can be provided easily by a picture-tube phosphor having moderate persistence. Green willemite phosphor has been found to be quite adequate. The decay in intensity in one line is negligible. After 30 msec, the intensity is less than 10%. Thus, there is very little carryover of the signal image

*In practice, for simplification in equipment design, the rates of 24 and 25 are used interchangeably when other than the 525-line, 30-frames/sec standard is used.

Table. I. Transmission Parameters of Significant Importance in Standards Conversion Are Tabulated for Europe and the United States.

	Great Britain	United States	Western Europe	France
Scanning lines (per frame)	405	525	625	819
Line frequency (CPS)	10,125	15,750	15,625	20,475
Frame frequency (CPS)	25	30	25	25
Bandwidth (MC)	3	4	5	10.4

Presented on May 11, 1961, at the Society's Convention in Toronto by K. Blair Benson, Engineering Dept., CBS Television Network, 485 Madison Ave., New York 22.

(This paper was received on April 22, 1961.)

to the next frame 40 msec later. There is some carryover from field to field, though, which does contribute to a small loss in vertical resolution. As will be pointed out in following paragraphs, this is of no consequence since the vertical spot wobble necessary to eliminate interline beat patterns reduces vertical resolution still further.

Again, it is emphasized that this mode of operation is dependent upon the field scans of the input and output systems being synchronized and in phase. If, for example, the output scan is permitted to lead the input scan, storage is required for the duration of one field or 20 msec.

The conversion between the American standard of 525 lines and any of the foreign standards introduces a storage requirement analogous to that in the conversion between nonsynchronous 50-cps field rates. The 525-line picture is scanned at a field rate of 60 cps. The duration of the field scan is approximately 16 msec, compared to the European value of 20 msec. Input and output scans coincide only once every six 525-line fields or conversely, every five 625-line fields. The period between coincidence is equal to 0.1 sec.

Thus, because of the decay in phosphor intensity, after excitation by its scanning beam the camera output signal will vary in amplitude at a rate corresponding to the period of scanning coincidence. This 10-cps amplitude variation is dependent upon the decay-rate of the picture tube phosphor and, in addition, the storage capability of the camera pick-up tube. Unfortunately, unlike the line-only conversion case where storage is required only for a very small part of a field, it is not feasible to provide full field storage by means of a very gradually decaying phosphor. Were this done, the high level of residual image carryover to successive fields would appear as intolerable smear of moving objects.

Although willemite phosphor has been found to provide an acceptable compromise between necessary storage and permissible image carryover to successive fields, the persistence falls far short of the value necessary to cover the 0.1-sec period during which there is a lack of coincidence of the input and output scanning actions. However, the additional storage capability can be provided in the pick-up tube more effectively and with less carryover because partial erasure is accomplished by the action of the scanning beam. Nevertheless, even with the use of a long-persistence phosphor and a storage-type pick-up tube, the residual 10-cps rms amplitude variation accompanying a 60 to 50 cps field-rate conversion is in the order of 5%. The value is slightly greater. or approximately 8%, for a 50 to 60-cps field-rate conversion because of the greater phosphor decay during the longer duration, 50-cps field.

At the television receiver brightness employed for normal viewing, according to the Ferry-Porter law, any variation in intensity in excess of 1% rms of the maximum picture intensity at a 10-cps rate can be perceived by the eye. Obviously the 5% rms fluctuation noted above for a 60 to 50-cps field-rate conversion would be extremely objectionable. Some form of compensation is required to reduce the flicker below the maximum acceptable rms level of 1%.

Flicker Correction

Correction for the 10-cps amplitude variation can be applied in any of several ways. All methods in general use to date rely upon the modulation of a variable-gain video-amplifier by a suitable 10-cps correction signal. The amplifier may be in either the input or output channels of the converter system. The modulation may be derived by a manually adjusted generator, or developed and controlled by some means of peak detector in the camera output channel.

Manual Correction Systems

The first successful commercial use of field-rate conversion between national transmission standards was accomplished in 1958 by the Granada Television Network in Manchester, England, during the Eurovision transmission of the Coronation of Pope John XXIII in Rome. Signals on 625-line, 50-cps CCIR field standards were converted by BBC at Dover to British 405-line, 50-cps field-rate standards.[1] These signals were transmitted to London Airport where they were converted to U.S. 525-line, 60 cps field-rate standards and then recorded on video tape. The tapes then were flown to New York for release the same day over the CBS Television Network.

The Granada system employed a locally generated 10-cps waveform signal adjustable in amplitude and phase to appropriately modulate the gain of a video-amplifier in the camera chain output. Willemite picture-tube phosphor and a special 4½-in. image orthicon having a very close target-to-mesh spacing were employed. The close-spaced pickup tube provided a maximum signal-to-noise ratio and a high degree of storage. The long storage time somewhat reduced the flicker correction problem.

Although quite acceptable picture quality was produced, two major problems were evident. For one, the high storage capability of a close-spaced image-orthicon target results in excessive image carryover for several fields and produces disturbing "tails" on fast moving objects. Secondly, the flicker correction required frequent manual adjustment. After a short time, operators unconsciously develop a tolerance to flicker and consequently have difficulty perceiving when optimum correction has been achieved.

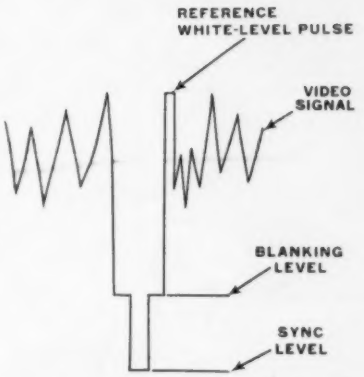

Fig. 1. Waveform of composite video signal showing white-level pulse inserted to actuate automatic flicker correction circuitry.

Furthermore, the image orthicon produces a second flicker component which is apart from that accompanying the decay in phosphor light output following the passing of the picture-tube scanning beam. This electron redistribution action, sometimes called "photo-effect," is similar to the function of a simple photoelectric cell and produces a signal dependent upon the total light output of the picture tube rather than the instantaneous brightness of any one spot. Thus, an interfering signal component at the field-rate of the unconverted input signal is present in the converted output signal.

In 1959 CBS surveyed the many converter systems in operation in Europe in an attempt to determine what type of equipment would best suit its forthcoming operational needs. The only unit other than Granada's which was capable of converting between U.S. and European standards was a laboratory model designed by Fernseh, GmbH., in Darmstadt, Germany. This latter concern had been active in the field of television standards conversion for several years. In 1954 they delivered a vidicon-type line-scan converter unit[2] to the West German Post Office, Cologne, for use in the Eurovision link between Germany and Belgium. In 1959 they were constructing a second unit for similar use between Germany and France.

Fernseh System

The 525-line design employs an automatic flicker correction circuit in the vidicon camera chain. An indication of the flicker correction required is obtained from the peak fluctuation of a reference white level pulse inserted on the back-porch of the input signal. The waveform of this signal is shown in Fig. 1. A gated peak-level detector in the camera produces an output signal which varies in accordance with the 10-cps

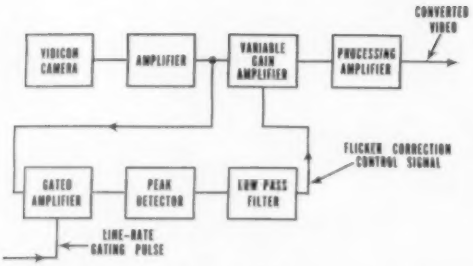

Fig. 2. Automatic flicker correction system.

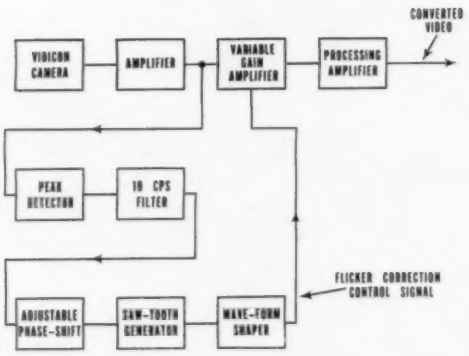

Fig. 3. Manual flicker correction system.

fluctuation of the reference pulse. This signal, in turn, controls the gain of the camera video-amplifier inversely relative to the level of the reference signal. Subsequent blanking insertion and clipping circuits in the vidicon camera channel remove the reference pulse from the converted signal, and an essentially flickerless signal having standard waveforms results from these operations. Figure 2 is a simplified block diagram of the correction system.

The "no-hands" operation of the automatic circuit demonstrated in a laboratory evaluation, coupled with the inherently stable characteristics of a vidicon, prompted an engineering decision in favor of this converter design. Accordingly, primarily in anticipation of requirements for the 1960 Olympic Games in Rome, an order was placed for one unit. Delivery was scheduled for early 1960.

CBS System

During the period prior to delivery of the aforementioned production unit a sudden increase in international diplomatic activity, coupled with the wedding of a British Princess, created an immediate need for a four-standard converter. Consequently, a crash program was undertaken, just prior to the 1960 Summit Conference in Paris, to construct a unit somewhat less elegant than the Fernseh design, but nonetheless adequate to cover these many important news events of world-wide interest.

A television film recording monitor was used as the basis of the picture display unit. The usual 16mm film recording camera was replaced with a standard vidicon telecine camera. In lieu of the availability of automatic flicker correction circuits, a simpler, semiautomatic correction system was designed and installed temporarily.

Figure 3 is a simplified block diagram of the correction system. A 10-cps signal synchronous with that in the converted signal was obtained by means of a peak white detector followed by a 10-cps bandpass filter. This low-frequency signal was used to trigger a correction waveform generator, the output of which modulated a variable-gain amplifier. The shape and phase of the correction signal were adjusted manually for minimum flicker in the output signal.

This arrangement provided a reduction in the peak-to-peak flicker component to an acceptable level. Subsequently, the manually operated unit was replaced with a Fernseh laboratory model which, in addition to being automatic, provided the necessary reduction in flicker level to an rms amplitude of 1%.

Converter Description

The length of the foregoing discussion may have tended to imply that the problem of flicker correction is the only one requiring a significant degree of engineering attention. This is far from the truth if a high level of broadcast picture quality is to be achieved and maintained with a minimum of operating attention. A properly engineered converter system includes all of the electronic complexity found in a television film recording operation, combined with a vidicon camera playback system such as used for telecine transmission. The only functions not required are the film processing, printing and projection. This will be readily apparent from a description and a summary of performance characteristics of the converter system which CBS employed in Rome to cover a major portion of the Olympic Games.

Figure 4 is a block diagram of the input side or picture monitor display system. The video-amplifier incorporates an adjustable nonlinear transfer characteristic to correct for converter shortcomings in the form of black compression produced by flare in the optical system and white compression resulting from slight overload of the phosphor screen material.

The high-frequency, zero phase-shift amplitude boost necessary to compensate for the normal aperture losses in the picture tube phosphor and its electron scanning beam is introduced in the converter input amplifier. In addition, this preconversion equalization provides partial correction for the optical system and vidicon camera aperture losses. The latter compensation is not rigorously correct since in the lowlights the signal swings blacker than black and, consequently, does not produce an increase in the peak black camera signal. Nevertheless, it results in a desirable subjective increase in horizontal resolution. If instead all of the required correction were inserted after the vidicon pickup tube, the visibility of the fixed grain pattern of the phosphor screen and the random noise level would be increased materially.

No attempt is made to correct for the comparable resolution losses in the vertical dimension for two reasons. First, the equipment necessary to provide vertical aperture correction is excessively complex. Second, vertical correction techniques would provide little reduction in the far greater losses resulting from differences in input and output scanning rates. This fact, incidentally, negates any advantage of the image orthicon over the vidicon on the basis of its inherent higher resolution.

Automatic peak white and black level circuits are provided to maintain maximum amplitude modulation of the picture-tube beam. Thus, maximum signal-to-noise ratio is obtained under varying input signal conditions. This automatic gain control action is particularly useful on transmissions where

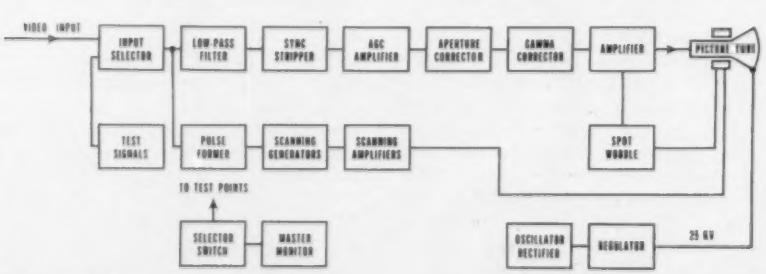

Fig. 4. Converter input system.

no control can be exercised over the pick-up or the network level control.

Vertical spot-wobble of the beam at a 15-mc rate is used when converting among the 405-, 525-, and 625-line standards. Thus, the low-frequency beat-pattern which would be produced by the camera tube scanning beam passing over the dark spaces between the input picture-tube scanning lines is avoided. The finer structure of the 819-line scan eliminates the need for spot-wobble when converting to or from this standard. The spot-wobble signal is amplitude-modulated by a negative polarity video signal since the increased spot size normally accompanying higher beam densities results in narrower dark areas between scanning lines. Thus, a loss in highlight resolution is avoided.

Check and adjustment of aperture correction, gamma correction and signal levels are facilitated by test signals from generators built into the equipment. In the absence of an input signal, an internally generated line-frequency pulse can be used to drive the test signal generator.

The vidicon camera portion of the converter is a standard high-quality telecine unit to which has been added the automatic flicker correction circuitry described previously. The block diagram is shown as Fig. 5. A synchronizing pulse generator provides the necessary composite blanking, synchronizing and camera drive signals.

In order to eliminate random variations in the flicker correction signal, circuitry is included to lock the input channel synchronizing pulse generator to the output vertical scan timing. This is of greatest value in flicker reduction when the conversion is among European standards. However, it is of negligible importance when converting to or from the American Standard because in this case the normal flicker component is comparable in amplitude to that which would result from non-synchronous input and output field rates.

A low-pass filter having a passband characteristic appropriate for the particular output standard in use is provided in the video channel. A slide projector can be swung into the vidicon optical path, thus permitting alignment of the camera with test pattern slides independent of the picture monitor unit.

Performance Characteristics

Ideally, standards converter performance should introduce no distortion or degradation of any sort in the picture signal. This would necessitate that (a) the video amplitude transfer characteristic be unity, (b) the video frequency response be flat over the passband of the converted system, and (c) the video noise level be significantly

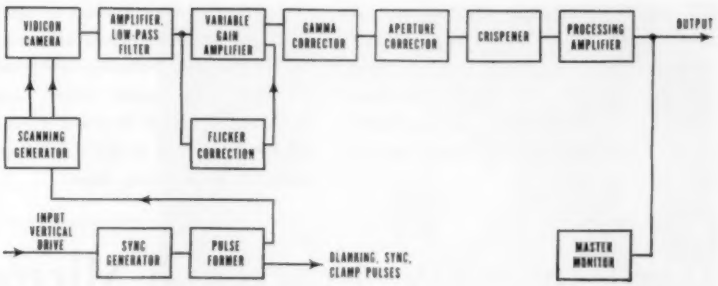

Fig. 5. Converter output system.

below that of the input signal. Furthermore, the scanning geometry of the display and pickup systems must be essentially identical.

These requirements were essentially fulfilled by the converter equipment used by CBS in Rome for the Olympic Game pickups in 1960, and since that time in New York (Fig. 6). The overall signal-to-noise ratio, with appropriate weighting factors for the peaked channel characteristic of an aperture corrected vidicon, is over 40 db. When operating at an output standard of 525 lines, 60 fields/sec, the frequency response at the raster center is down only 2 db at 4 mc. The corner resolution is down only 4 db. Errors in scanning geometry for the overall system are less than 1%. This degree of accuracy is achieved with the 20-kc line rate of the 819-line system as well as at the slower scans employed for 405- and 625-line standards.

Conclusion

At the onset, in this day and age of rapid electronic advancements, it may appear somewhat primitive to resort to signal conversion by "taking a picture of a picture," even though the photographic industry has employed this technique for many years with unquestionable success. Instead one would presume that some form of all-electronic translation of the video signals, such as those currently employed for radar displays, would be adaptable. Unfortunately, the present state of the art in these more sophisticated dual-scanning storage devices does not provide the contrast range and resolution capabilities required for the television system. On the other hand, the picture monitor and vidicon camera type of standards converter has proven, in regular day-to-day operation in the CBS Television Network New York Video-Tape Recording Facilities area, to adequately meet these and other stringent requirements of television broadcasting.

The many unpredictable changes in the international situation and future international program plans make it

Fig. 6. Standards converter employed by CBS for international program exchange. The two racks at the right contain input and output monitoring facilities, controls and the accompanying circuitry. To the left of the racks is a cabinet supporting the display tube and the vidicon camera. The rack appearing at the extreme left is a CBS-designed unit containing auxiliary audio, video and intercommunication equipment necessary to integrate the converter system with video-tape and studio facilities.

difficult to predict the exact nature of future standards converter applications. However, the success achieved to date indicates that we may expect standard conversion to continue as an important part of our television broadcasting operations.

A valuable contribution to this paper has been the assistance of Alfonso Cosentino of the CBS Television Network Production Development Dept., and the encouragement of Howard Chinn and Richard O'Brien of the CBS Television Network Engineering Dept.

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1. A. V. Lord, "Standards converter for international TV," *Electronics, 26:* 144–147, Aug. 1953 (also *B.B.C. Quarterly, 8:* No. 2, 1955); and T. Worswick, "The B.B.C. Television Standards Converter," *Jour. SMPTE, 68:* 130–135, Mar. 1959.
2. Wolfgang Dillenburger, "Normwandler mit Vidikonkamera," *Archiv der Elektrischen Uebertragung, 12:* 209–224, May 1958.

High-Intensity, Fractional-Microsecond Light Sources

By PHILIP NOLAN

High-intensity light sources have been developed for military applications in optical ranging, communications and navigation. These sources provide a small-area electric spark with a peak brightness of approximately 50 million candles/cm², and a duration of less than 0.5 μsec. These sparks may be operated at resonant frequencies or triggered accurately by triggering electrodes. Normal frequencies of operation up to several kilocycles are possible under certain conditions. Spectrographic measurements indicate an effective blackbody temperature of the order of 30,000 K. Developmental work has included experiments with spark atmospheres of various compositions and pressures.

THE PRESENT discussion of the Farrand pulsed light source is based on the experience of a large number of staff members who have been engaged in its development. The work on lamp development was initiated under U.S. Navy, Bureau of Naval Weapons auspices. The work has had the support of various members of the Defense Department including the Air Force and Army, in addition to the Cornell Aeronautical Laboratory and the Martin Co.

Our primary objective has been the development of a source of light of maximum brightness, in small volume, with the shortest possible rise time. The emphasis on small volume of the radiation and short rise time was required by the basic system design of our pulsed light ranging equipment.

Our work has lead to the production of two main types of pulsed light sources. They are sparks in air or high-pressure gas. The condenser which stores the energy to feed the spark is an integral part of the lamp structure. The principal design effort has gone into the mechanical and electrical design of the condenser and structure which mounts the electrodes. The typical pulsed light source is illustrated in Fig. 1.

Presented on October 17, 1960, at the Fifth International Congress on High-Speed Photography in Washington, D.C., by Philip Nolan, Farrand Optical Co., Inc., 4401 Bronx Blvd., New York 70.

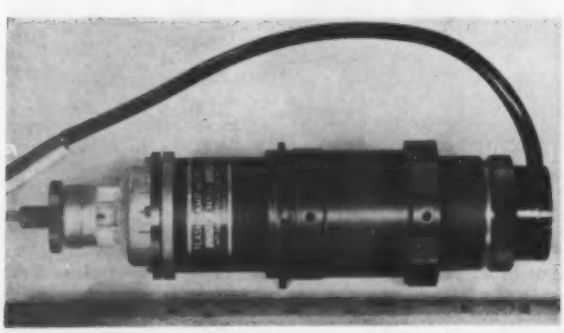


Fig. 1. A typical pulsed light source.

Characteristics

The latest model, Model 9, source is a tungsten electrode spark gap in air of 0.030-in. gap length. The diameters of the tips are 0.030 in. A metal ribbed cage surrounds the gap to provide the best approximation to a concentric transmission line. The condenser which feeds the gap is specially wound with the result that the inductance of the condenser itself is less than 10^{-10} h. The measured inductance of the complete electrode and condenser structure is 2×10^{-9} h. The capacitance is 0.8 μf.

The pulse shape of the light intensity shows a rise time of 0.12 μsec and a pulse length of 0.375 μsec. The energy input per pulse is 5.0 j/flash. The peak electrical current in the gap is 35,000 amp. The peak power radiated in the visible and ultraviolet regions of the spectrum is 150,000 w.

It is noteworthy that the present structure is not critically damped. The resonant frequency of the structure is 2 megacycles/sec. In the Model 8 lamp the output light pulse shows modulation of the light output at 10 megacycles/sec of 10% on the decaying slope (Fig. 2).

The light output characteristics are as follows. The maximum brightness is 60×10^6 candles/cm². The peak horizontal candlepower is 1.3×10^6. This leads to a total output per pulse of 0.34 horizontal candlepower sec.

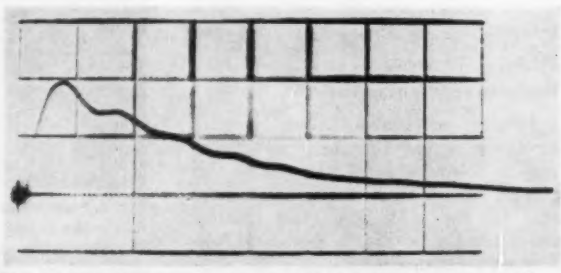


Fig. 2. The light output of the Model 8 light source. Time scale: 10^{-7} sec/division.

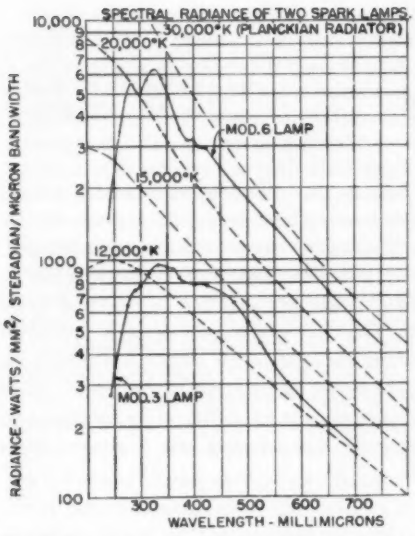


Fig. 3. Spectral radiance of blackbodies and of two spark lamps.

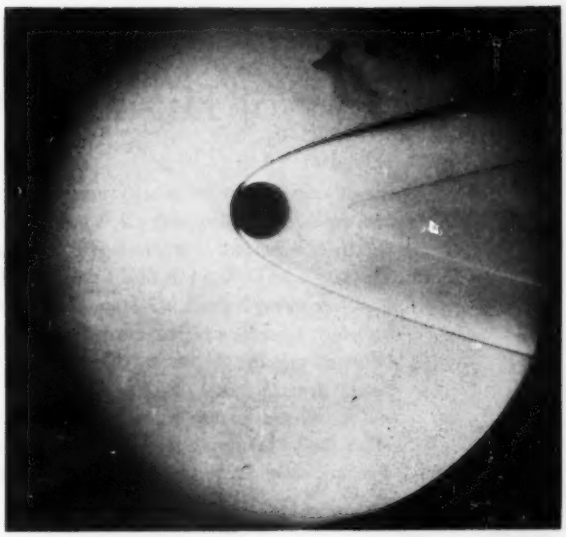


Fig. 4. Photograph of 0.5-in. diameter sphere projected at 7700 ft/sec using a pulsed light source. (Official U.S. Navy Photograph)

The angular distribution is essentially spherical except for the shadows of the cage ribs and the electrodes. The total solid angle illuminated is approximately 3π steradians.

The spectral distribution of the lamp is shown in Fig. 3. The color temperature and brightness temperature determined by the best fit to the blackbody curve is 30,000 K. This is true for wavelengths out to 12 microns.

Operation

The source radiates a continuous spectrum for the first 0.1 to 0.3 μsec. During this time the source is opaque to its own radiation. The normal spectrogram shows broadened lines superimposed on a continuous spectrum background. The spectral distribution curves after the first microsecond exhibit different pulse lengths in time for different wavelengths throughout the spectrum. This variability leads to the necessity of determining the effective photographic exposure directly.

The effective photographic exposure times determined by two independent methods is less than 0.2 μsec. The effective photographic exposure time determined by the amount of image blur of pellets traveling at a speed of 7000 ft/sec is less than 0.2 μsec. This is shown by Fig. 4. For a photographic exposure time of 0.2 μsec, the photographically determined output is 1 horizontal candlepower sec.

It is possible to obtain photographs by means of reflected light photography of large areas using the pulsed light source. For example, it is possible to obtain single flash exposures of 0.2-μsec duration with the source illuminating an area of 10 by 10 ft at a distance of 20 ft when an $f/0.87$ Super Farron lens is used.

If the high-speed photography problem requires a relatively small area throughout which photographs may be obtained, then it is most efficient to employ a mirror condenser system to illuminate the subject area. For example, using the Farrand pulsed light source and a 24-in. diameter parabolic mirror, it is possible to obtain single flash photographs by reflected light at 0.2-μsec exposure with an $f/30$ lens.

The Farrand pulsed light source is ideally suited for use with gated image tubes for extremely short time photography. The pulsed light source has been used with a gated image orthicon for 0.25-μsec exposures of natural terrain in daylight. For example, the beam candlepower of the searchlight used in this application for illuminating natural terrain was 1.8×10^{11}. Using this source, it then becomes theoretically possible to obtain shadowgraph exposures in a 100-line picture for a 10^{-10}-sec exposure time.

Ed. Note: The Fifth International Congress on High-Speed Photography was sponsored by the SMPTE and supported in part by the Departments of Army, Navy and Air Force through a grant administered by the Chief Signal Officer of the Army. Congress papers and related discussion will be published in the *Proceedings* of the Congress.

New Technique for Measuring the Velocity of High-Speed Objects

By DONALD A. HALL
and W. W. ATKINS

A new technique for the velocity measurement of controlled trajectory particles, projectiles, models or other objects has been developed for laboratory use in the study of ballistic phenomena. One principal advantage of this system is that the velocity of individual objects throughout a wide velocity spectrum can be measured for any given firing of the accelerator. The system employs a standard Fastax streak camera for film transport. Collimated light fields are placed along the trajectory through which the projectile or particle will pass. A narrow vertical slit, near and perpendicular to the trajectory, provides a submicrosecond shutter when image demagnification times rate of film travel equals or approaches the object velocity. A series of mirrors rotates the slit image 90°, enabling the light field to produce a ribbonlike exposure along the entire length of film. A projectile entering the light field creates an instantaneous shadow at the slit and is recorded as such on the film. This is repeated at two or more carefully spaced stations along the trajectory. With the projectile images and time-base markers produced simultaneously, it is necessary only to measure image displacement and determine rate of film travel to calculate object velocity.

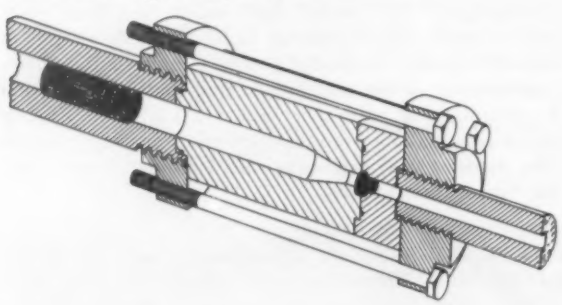
A TECHNIQUE BY WHICH the velocity of a high-speed fragment, model or other object may be accurately determined has been developed at the U.S. Naval Research Laboratory. To date its application has been restricted to the velocity determination of a projectile, but this is by no means necessary. The technique should be useful in such fields as aerodynamics, magnetohydrodynamics or other areas of research involving high-velocity studies.

In ballistics research several methods have been developed to measure projectile or fragment velocity. These include the ballistic pendulum, large magnetic coils through which the projectile is fired, circuit elements located in the trajectory which are either opened or closed by the passage of the projectile, the use of a high-speed framing camera, spark or x-ray photography and measurement of streak angle obtained with a drum camera. Dependent upon the specific requirement, one or more of these methods may be employed. In the velocity range above 3 km/sec, however, discriminating projectile detection, particularly of a nonmetallic material, and synchronization of the projectile with the recording instrumentation become more difficult. This difficulty is due partly to the type of projectile accelerator employed and partly to the projectile configuration.

An accelerator developed at NRL consists of a device which utilizes a highly compressed low-molecular-weight gas, such as helium or hydrogen, to propel a lightweight projectile (Fig. 1). Gas compression is achieved by a piston fired down a compression tube by means of a solid propellant (gun powder). A typical gun design consists of a 20-mm compression tube, an expendable coupling which stops the piston, and a 7.62-mm barrel or launch tube. A shear disk, which may be either an integral part of the projectile or a separate piece, is located between the expendable coupling and launch tube. This constrains the low-molecular-weight gas during compression until the pressure exceeds the shear strength of the disc. By the use of this type of accelerator, velocities in excess of 6.8 km/sec have been achieved.

If the sheared material of the disc is not an integral part of the projectile, then the projectile, projectile carrier (referred to as a sabot), and shear disc are all accelerated to a high velocity. The compression piston impacts into the expendable coupling, and frequently part of the piston extrudes into the bore of the launch tube. Often this extrusion fails in tension and leaves the muzzle with a velocity of as much as 1 km/sec. Hence, for an accurate measurement of projectile velocity a technique which includes positive identification of the projectile is imperative.

Presented on October 21, 1960, at the Fifth International Congress on High-Speed Photography in Washington, D. C., by D. A. Hall (who read the paper) and W. W. Atkins, Ballistics Branch, Mechanics Div., U.S. Naval Research Laboratory, Washington 25, D.C.



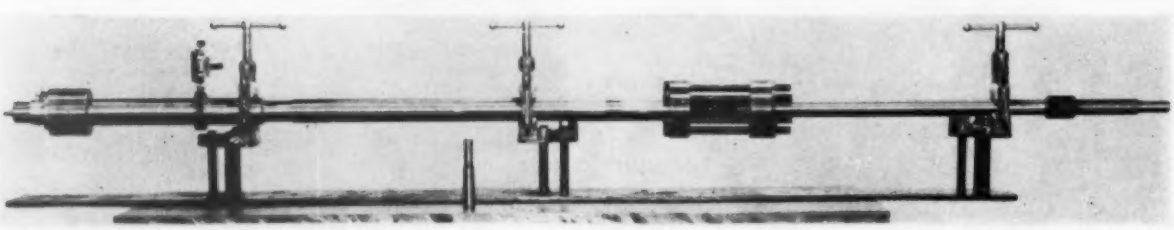


Fig. 1. NRL-type gas gun.

A new velocity-measuring technique has been developed which produces a photographic time-vs.-displacement record and yields shadowgrams not only of the projectile but also of the sabot pieces, shear disc, piston extrusion, and any shock disturbances associated with these pieces.[1] The system consists of two optical recording stations separated by a known distance, a Fastax camera, and a mirror system which will project the horizontal images of the slits into a straight line across different sections of the film. Camera coverage is for a period of approximately 40 milliseconds, although this can be widely varied, and the effective exposure time, which also can be varied, is usually less than 0.1 microsecond. Film speed is determined from timing markers placed on the film by a high-frequency lamp.

The optical arrangement for one of the recording stations is shown in Fig. 2. A continuous light source is projected into a standard Fastax streak camera and the camera is focused on the vertical slit. As the projectile and related pieces pass through the field of light, shadows of these are cast upon the vertical slit and recorded as such on the moving film, producing a shadowgram similar to that which would be obtained by use of a short-duration spark source. If the camera is operated in the normal upright position, it is necessary to rotate the image of the slit and projectile 90° so that image motion will also be in the vertical plane. From a consideration of optical magnification, film speed and projectile velocity, the relative motion between the film and projectile image can be reduced to a minimum — ideally this minimum would be zero. The effect of a mismatch between film and projectile velocities is a moderate foreshortening or lengthening of the image relative to the actual projectile length. Image width is a function only of object width and magnification of the system.

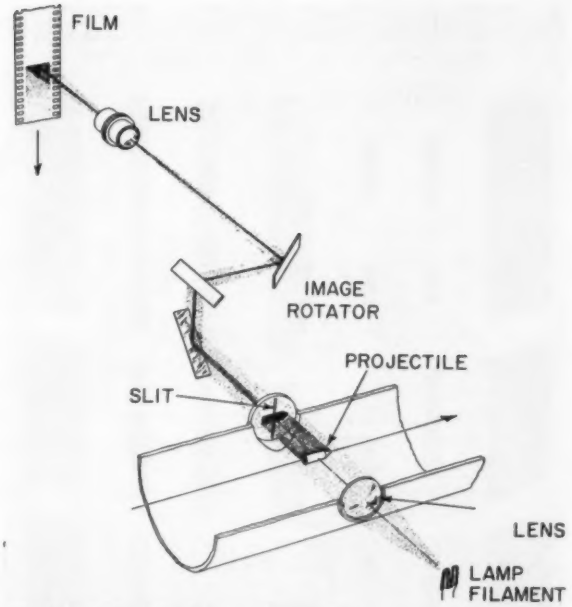


Fig. 2. Details of single recording station.

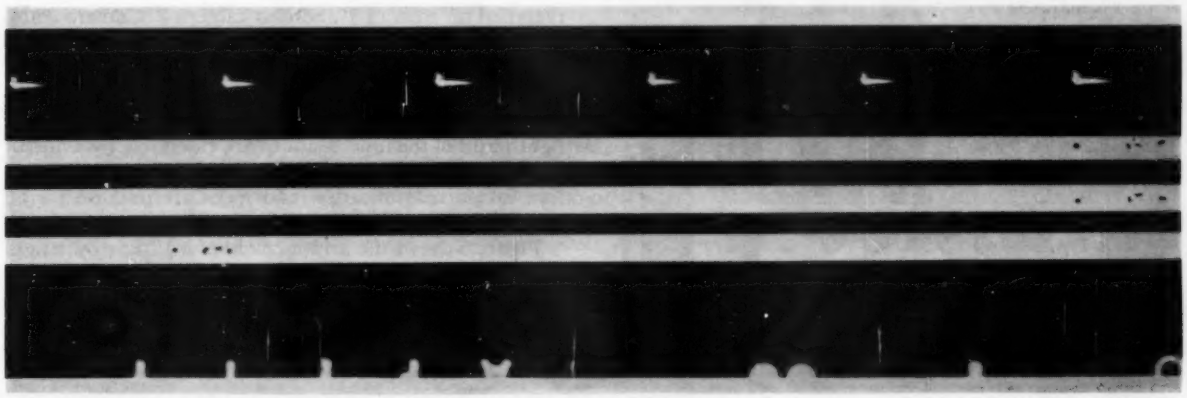


Fig. 3. Two-station velocity record.

Synchronization of a camera and projectile is accomplished by use of the frame-count technique developed earlier at NRL for ballistic photography.[2] In this system an induction probe is placed close to the teeth of the drive sprocket of the camera. The pulses produced are fed into an electronic dual preset counter. When a predetermined number of counts has been registered, an output pulse fires the projectile accelerator. The projectile images are recorded at approximately the 90-ft point in a 100-ft roll of film. Thus the maximum framing rates for image recording are utilized. At a second preset

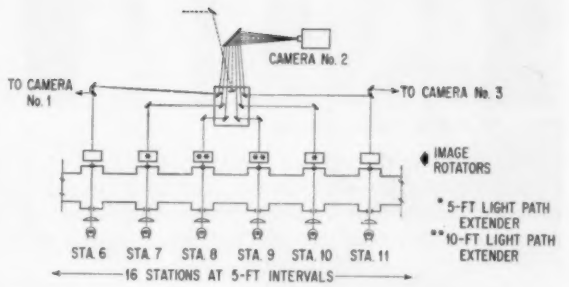


Fig. 4. Six-station optical schematic.

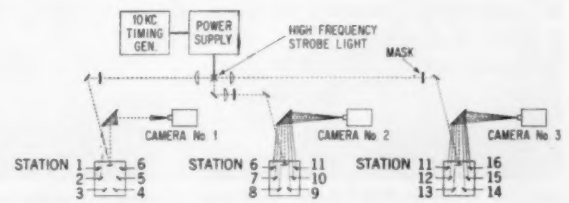


Fig. 5. Timing light and camera arrangement.

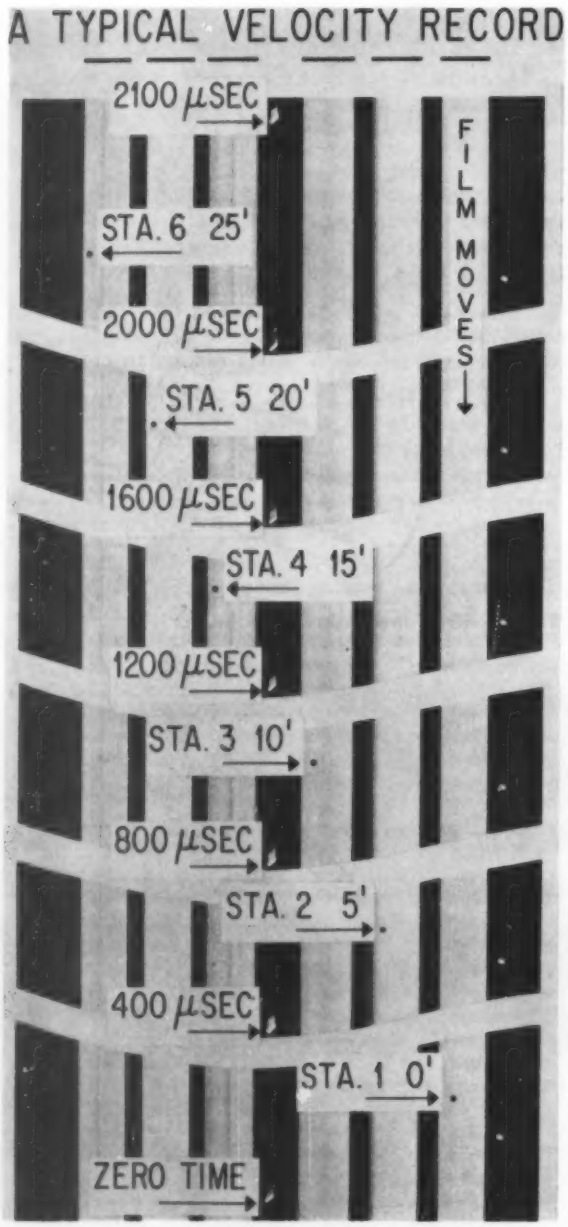


Fig. 6. Six-station velocity record.

count, power to the camera is interrupted. Loss of film caused by whipping after the roll has passed through the camera is minimized by interrupting the power a few feet prior to the end of the film. This is particularly effective at the maximum framing rates, where considerable film is normally lost.

Projectile images and time-base markers are carefully measured with a comparator at a magnification of 100×. Since image displacement is measured from the leading edge of one image to the leading edge of the next image, any distortion of the projectile length has no effect on the accuracy of the displacement measurement. Hence the velocity of the projectile and of any other piece, including the slow piston extrusion, can be calculated. Figure 3 is a typical velocity record of a spherical projectile and several sabot pieces. At the first station only a horizontal projection is recorded. At the second location, optical systems were arranged to obtain both horizontal and vertical projections. Sphere velocity was 3.59 km/sec.

The basic system measures velocity over one trajectory interval. Repetition of the optical elements of the system provides velocity measurements for additional adjacent trajectory intervals. At NRL one ballistic range facility useful for aerodynamic studies is instrumented to record projectile velocities in 5-ft intervals for 75 ft of travel. In this system three cameras are employed in recording a total of sixteen stations. Figure 4 is a diagram of one section of this range. By the use of additional mirrors, each camera records six stations. The image beam at station 6 is divided by a half-silvered mirror so that it is recorded on camera 1 and also camera 2. Camera 2 also records the next five stations, with the image from station eleven being reflected into both cameras 2 and 3. Camera 3 records five new stations for a total of sixteen. All stations are equidistant from their respective cameras. The light paths of the inner stations are extended, by a mirror system, to the exact distance of the outer stations. Therefore image magnification and focus are uniform for all cameras.

Figure 5 shows the arrangement of a 10-kc strobe light and optical system for producing a uniform time base for all cameras regardless of film speed. Sharply focused time marks are obtained by a diagonal slit placed in each optical path at a point equidistant to those of the trajectory slits.

By the overlapping of photographic records and common time base markers, all data from the various cameras can be correlated. Figure 6 is an example of the record obtained when six stations are used. An analysis of errors indicates that the error in velocity over any 5-ft interval is approximately 0.25%.

References

1. D. A. Hall, "Photographic method for hypervelocity measurements," *Jour. SMPTE, 68:* 149–151, March 1959.
2. D. A. Hall and S. O. Bailey, "Synchronization of a high-speed prism camera by frame-counting technique," *Jour. SMPTE, 68:* 151–152, Mar. 1959.

Ed. Note: The Fifth International Congress on High-Speed Photography was sponsored by the SMPTE and supported in part by the Departments of Army, Navy and Air Force through a grant administered by the Chief Signal Officer of the Army. Congress papers and related discussion will be published in the *Proceedings* of the Congress.

High-Speed X-Ray Cinematography

By J. S. COURTNEY-PRATT

Image dissection techniques have been considered. A small fiber optics image dissection camera has been built. It will take ten pictures in a sequence at rates up to 10^6/sec using visible light. It is expected that it will be equally suitable for recording sequences of x-ray pictures at similar rates.

ONE OF THE LIMITATIONS common to most high-speed cameras is that they must work with visible light. Often the details that we would like to see are obscured by flame or smoke, and sometimes even by an opaque container. It is sometimes possible to record one picture of the event using an x-ray flash. The record then is usually a shadowgraph record. This involves two points. The dimensions of the x-ray shadowgraph have to be at least as large as the dimensions of the object. The resolution (in line pairs/mm) is usually not high because of penumbra effects and the finite size of the x-ray source. Because the dimensions of the format to record the shadowgraph are large, it is not possible to obtain sequences of pictures at very short intervals since one cannot displace and replace large pieces of film at a high repetition rate.

The obvious solution would seem to be to use a fluorescent screen, and photograph the fluorescent image with an ordinary cine camera. The major drawback of this idea is that it requires a much greater x-ray dose than do direct x-ray shadowgraphs.

If all the light from an area a^2 of the phosphor could be collected and caused to fall on an equal area a^2 of the film, the photographic effect would be little less than that that can be produced by direct x-ray shadowgraphs using the best intensifying foils or screens. However, a lens is very inefficient. We may make a rough calculation. Suppose we used an $f/2$ lens working at 1:1 magnification. The solid angle subtended by the lens at the phosphor is $\pi/64$ steradians. This is only 1/128 of the whole forward solid angle of 2π. Thus for a hypothetical uniform spherical emission distribution of light, and 100% transmission of light through the lens, the proportion of the light emitted that is transmitted to the emulsion is 1/128. For a practical emission distribution of light from a phosphor (which approaches a Lambert distribution), and for a reasonable value of lens transmission coefficient, the ratio of light falling on the emulsion to light leaving the phosphor is 1%. With wider aperture lenses this figure improves. The amount of light collected varies with the magnification m as the ratio $4(m/m+1)^2$. However as the area of emulsion on which it falls varies as m^2, the illumination B_m of the image in the copying camera (other things being equal) varies as $4/(m+1)^2$. That is, if B_1 is the illumination at unity magnification and if B_0 is the illumination for an emulsion in contact with the phosphor, $B_m = 4\ B_1/(m+1)^2$; $B_1 \doteq B_0/100$; $B_m \doteq B_0/25(m+1)^2$. For example B_m is no more than 4% of B_0 for an $f/2$ lens even with m vanishingly small. Again $B_m \doteq 10\%\ B_0$ for an $f/1$ lens at 4:1 reduction.

That is, in practice, if we photograph a fluorescent screen we need an x-ray dose 10 to 100 times greater than we would need with direct x-ray shadowgraphs.

My new suggestion is to combine the principles of image dissection and fiber optics to devise a camera that avoids the various difficulties mentioned just above.

A picture may be dissected into point image elements by any of a number of means; and provided there are

Presented on October 19, 1960, as part of a larger paper at the Fifth International Congress on High-Speed Photography in Washington, D.C., by J. S. Courtney-Pratt, Bell Telephone Laboratories, Murray Hill, N.J.

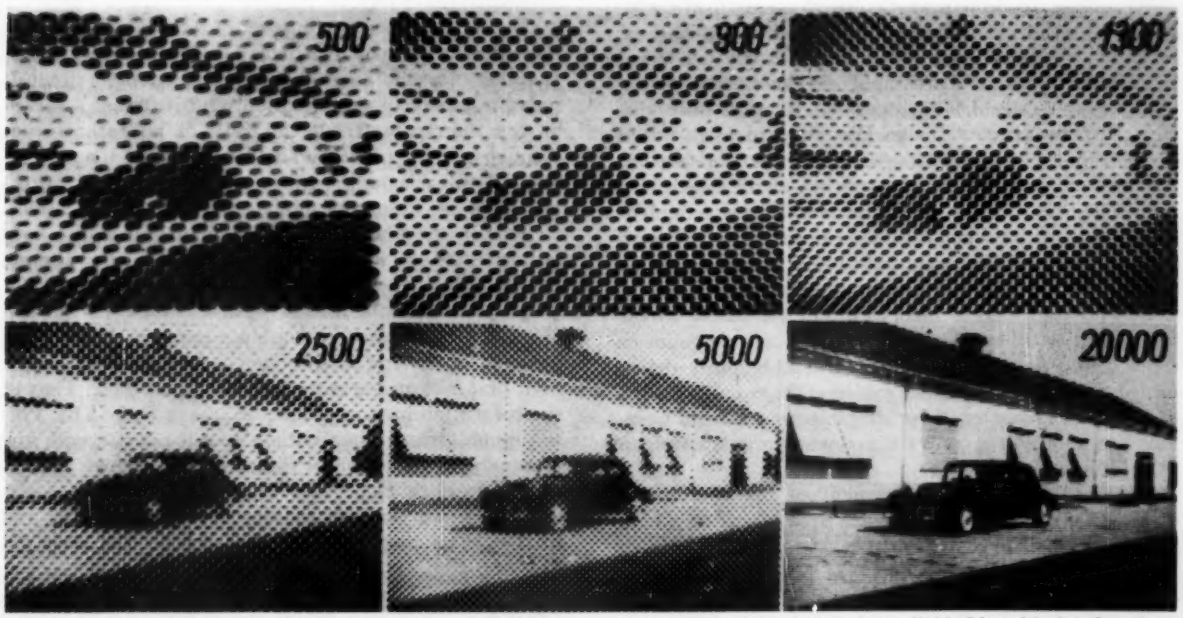


Fig. 1. A set of six pictures all of the same scene, but all of different resolution. The pictures have been divided into blocks of constant density. The total number of these blocks in each picture is indicated. (Courtesy of Professor H. Schardin.)

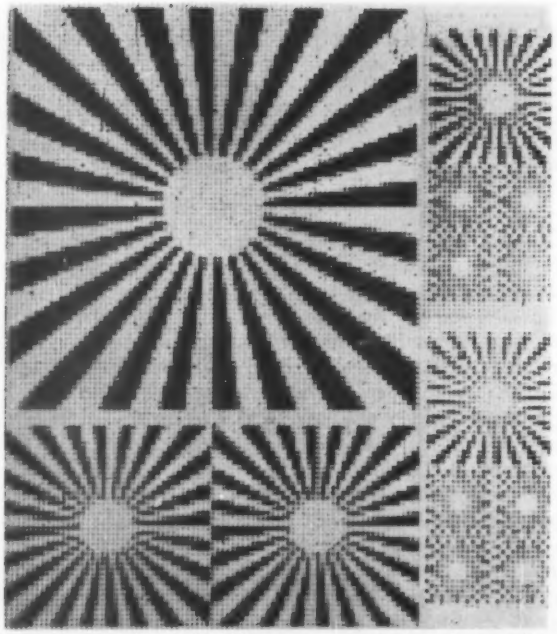


Fig. 2. A number of "rising sun" resolution charts taken through a dissection plate which had 130 elements from top to bottom of the frame.

enough points recorded, any given quality of picture can be reproduced. Professor Schardin[1] prepared a set of dissected pictures, all of the same scene, with different numbers of point elements. Figure 1 shows six views of a building and a car. For the second view the number of points is only 900, i.e., 25 × 36. It is barely possible to recognize the general features. Twenty thousand points (or more) constitute quite a reasonable picture. However, a quarter of this number would still often be quite acceptable as can be seen by reference to the fifth picture of Schardin's set.

We might ask how many point elements/mm correspond to a line pair/mm. There is no single answer. A similar problem exists with regard to the resolution in television pictures.[2] Cartwright and Cox have discussed halftone illustrations.[3] The question is more fully discussed in the article "Image Dissection in High-Speed Photography".[4] Figure 2 shows a number of rising-sun resolution charts. Where the spacing of the black and white lines is wide, they can be clearly counted. Ambiguities arise when the number of dots is less than 2 or 2½/line pair. One might thus take as one definition that $2n$ dots correspond to n line pairs. Simple application of the information theory sampling theorem would indicate that all spatial frequencies in an image lower than n line pairs/mm could be unambiguously determined from the brightness values at $2n$ equally spaced points/mm. However, these simple considerations overlook any question of contrast, and what exactly we mean by "resolving" a line pair.

Next consider the measurement of the coordinates of the edge of a sharp image of a solid object in a field of view. If the object is as large, at least, as the pitch spacing of the point elements, the position of its edge can be measured with an inaccuracy no greater than one pitch distance. In general, for larger objects the accuracy can be greater. Thus from this point of view

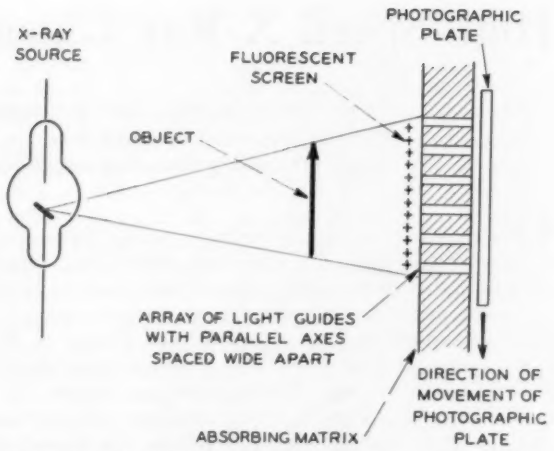


Fig. 3. The principle of the x-ray fiber optics image dissection camera.

the definition of equivalence is approximately that n dots correspond to n line pairs. For different purposes we shall use one or other of these two definitions, but bearing in mind that one is possibly too conservative, the other possibly too optimistic.

Figure 3 is a schematic diagram of the newly proposed device. An x-ray tube would cast a shadow of the object on to a fluorescent screen. Immediately behind the screen would be a fiber optics dissecting block.* If there are enough fibers within the dimensions of the x-ray image, the quality and resolution of the transmitted image will be adequately high. With the large flash x-ray tubes now in current use in many laboratories, the resolution of a typical shadowgraph is rarely better than 50 line pairs/in. and usually about 25 line pairs/in. Therefore we really need only to sample the image intensity at 2 points/mm (or perhaps at twice this spatial frequency). Let us assume then that the fiber block in Fig. 3 is made of fibers with the pitch spacing of their axes equal to 0.5 mm.

One of the major advantages of the fiber assembly is the efficient manner in which the fibers transmit light. If a fiber of a solid assembly has a high enough refractive index relative to the material around it (either a sheath or the matrix material), all rays of light that enter through a right plane end will suffer total internal reflection on each occasion they strike the walls. In practice there are losses due to end reflections and to imperfections in the fibers; but more than half of the light falling on the end of a short fiber is transmitted and comes out the other end.

A photographic emulsion pressed against the exit end of a fiber would thus receive, on a patch no larger than the area of the end of the fiber, a large fraction of the light that falls on the entrance end of that fiber. That is, the local illumination of such an image $B_f > \frac{1}{2} B_0$. This is a much greater illumination than is possible with any reasonable lens system, where, as was shown above, B_I is $\frac{1}{10}$ to $\frac{1}{100}$ of B_0.

Suppose we think of making the fibers smaller and smaller. The proportion of light transmitted does not

* Dr. R. F. Saxe[5] suggested that the fibers could themselves be made of a scintillator material. The depth available for absorption of x-rays could then be as large as desired — and this could be important if one wished to use certain fast decay organic scintillators which have a low absorption for x-rays.

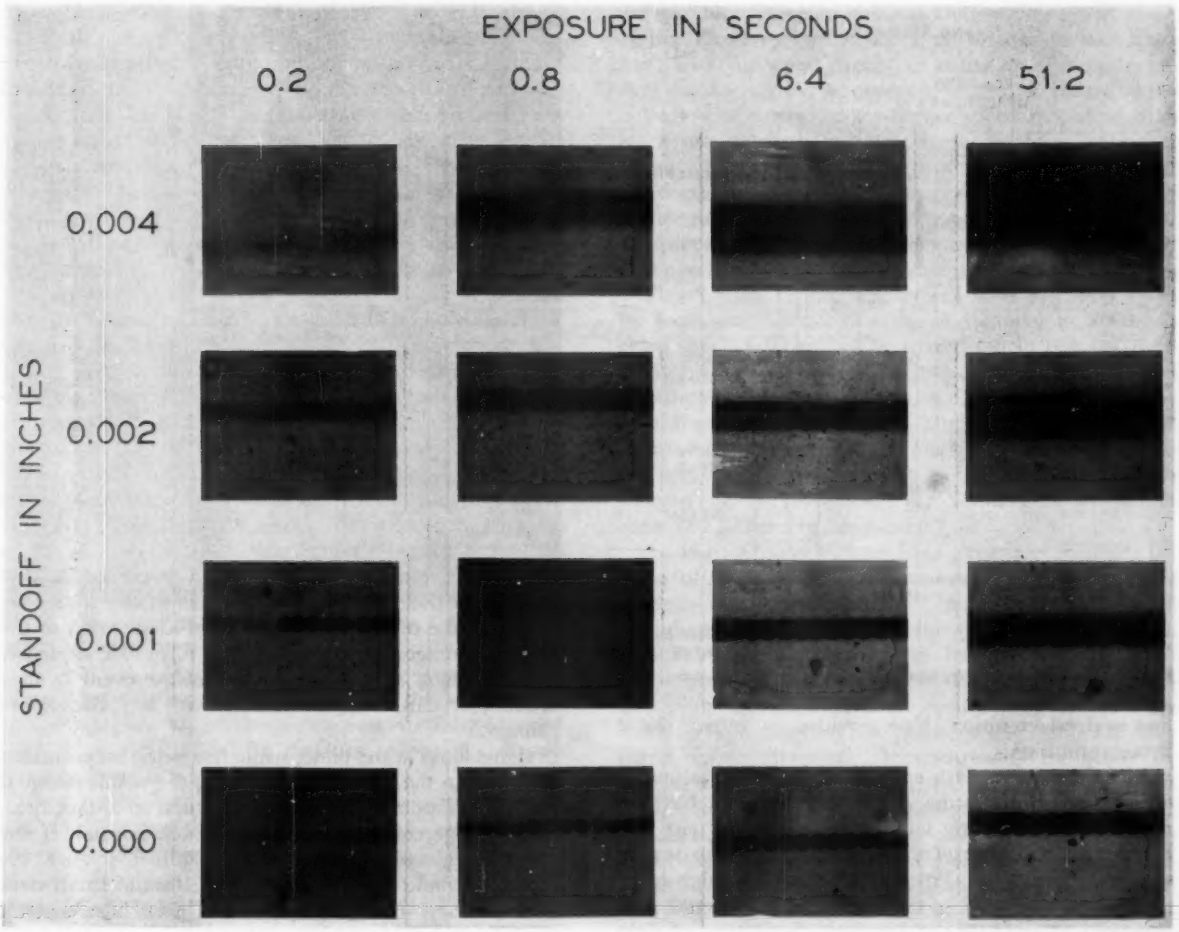


Fig. 4. Enlargements of the images recorded with fiber optics dissection for a number of exposure times, and for various standoff distances from the fiber block to the recording emulsion.

decrease appreciably until the diameters of the fibers are less than a few microns. The density of the photographic image formed on the emulsion pressed against the exit face would not be much reduced, even for small fibers, provided that the fiber diameter is large compared with the resolution of the emulsion. We could thus use fibers 25 to 50 microns in diameter, still maintain an efficient light transfer, and be able to record images of density not much lower than for direct shadowgraphs. If we produced a single flash of x-rays, and held a photographic plate against the exit face of the fiber block, the image that we would record would be made of small dots at relatively wide spacing. Now we could move a photographic plate sidewards by the width of the dot, and all fibers would be opposite unexposed emulsion. We could therefore record a second picture, also made up of dots — the whole picture interlaced with the last.

The distance we needed to move the photographic plate between exposures was the width of one dot, not the width of the plate. As this distance is some hundreds or thousands of times smaller, the time interval between successive recordings of a sequence could be correspondingly reduced. For example, if the fibers were 50 microns in diameter and the maximum traverse velocity of the plate were 5m/sec we could record at 10^5 pictures/sec.

To achieve a traverse velocity of 5m/sec, it is necessary to have some clearance between the photographic plate and the end of the assembly of fibers. The light coming out of the fibers is rapidly divergent. How big a clearance can be tolerated?

I had an assembly of fibers made up for me by the American Optical Co. The fibers were 50 microns in diameter. They were in rows, 500 fibers per row, with the pitch spacing of the rows 0.5 mm. A sheet of opal glass was placed near the front end of the fibers to simulate the diffuse light characteristics of a phosphor. The opal glass was illuminated with white light. A photographic plate was placed near the exit face of the block. Figure 4 shows a number of enlargements of the images recorded for various exposure times and standoff distances. It can be seen that there is reasonable working latitude without undue image spread if the standoff, or clearance, is less than about 0.001 in.

To traverse a photographic plate and keep it in one plane within such a tolerance requires accurate mechanical guides. It is also necessary to consider the flatness of the photographic plate itself. Ordinary plates are often too far from flat. However, Eastman Kodak microflat photogrammetric plates are flat well within this tolerance. Glass plates of this kind have been used for all the work with this camera. They are available with different emulsions, and the ones I have used most frequently are the Eastman Kodak type IV-O. This is a

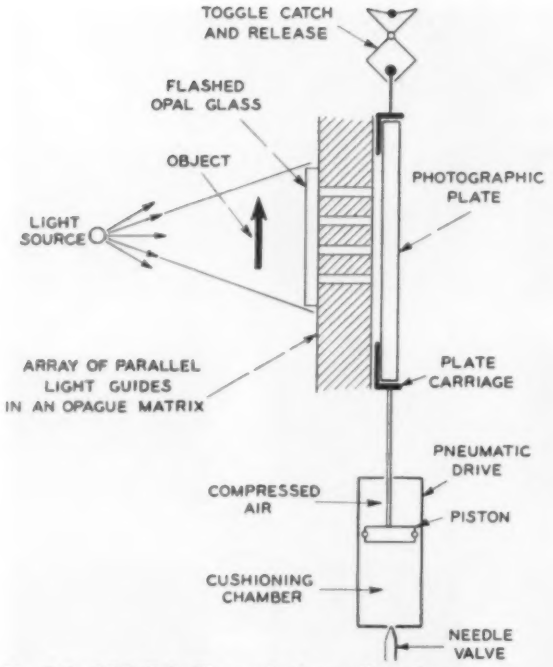


Fig. 5. A visible light fiber optics image dissection camera.

fine grained emulsion, blue sensitive — rather like a Process emulsion.

Repetitive x-ray flash equipment of adequate output does exist. I will discuss this further below. I have no such equipment at my laboratory, so I have tried out the optical analogue of the camera. The setup was as shown in Fig. 5. A Früngel "Strobokin"[6] high-speed stroboscope was used as the light source. An opal glass was used to simulate the Lambert distribution of light from a phosphor. The shadow image of an oblique mask and of a small timing wheel with slots and teeth of various depths was cast on the opal glass by each flash of the Strobokin. In the first set of experiments the photographic plate, mounted in its trolley, was allowed to fall 5 cm under gravity. The velocity was then about 100 cm/sec. A burst of 6 flashes at 12½ kc/sec on the Strobokin gave 6 images. Adjacent rows of dots were 80 microns apart, center to center. The dots for each fiber for each flash were clearly resolved.

To record at higher rates, a higher traverse speed for the plate was wanted. I built a pneumatic drive. The piston was 2¼ in. in diameter. Line pressure was 65 psi. Part of the cylinder acted as a high pressure reservoir. A toggle catch mechanism held the trolley. It could be released manually or by cutting off the current in a solenoid. The initial acceleration was 90 g dropping to zero in 3 cm when the peak velocity was 5 m/sec. The trolley was decelerated (at less than 100 g) by an air cushion at the other end of the pneumatic cylinder. There was a needle valve release to damp oscillations.

Another set of experiments was undertaken using this faster traverse mechanism. The illumination was provided by the successive triggering of 8 closely grouped spark sources driven by pulse equipment made by the Laboratoire Central de l'Armement.[7] Sequences of pictures were recorded (though rather faintly) at 66 kc/sec and at 100 kc/sec. The rows of dots were just resolved at the higher frequency.

As described above, in any one experiment a sequence of several dissected pictures is recorded, with all of the pictures recorded on the one plate interlaced with one another. It is necessary to "unscramble" the record to get back the individual pictures. This is achieved simply by replacing the photographic plate (after processing) in the trolley in the camera. The pneumatic drive is removed and a micrometer screw attached for precise movement of the trolley. The fiber block is illuminated with a small steady light source as shown in Fig. 6. The plate is carefully realigned. This can be accomplished using a microscope and a low level of oblique illumination so that all the dots in the field of view of the microscope can be seen, in addition to those brightly illuminated from below by way of the fibers.

Suppose the plate is aligned in exactly the same position that it occupied at the instant of the first exposure. Light coming through any fiber falls on that spot of the plate that it previously illuminated. The density of the record at that spot is the density corresponding to the instantaneous recorded image at that spot. Thus the light transmitted through the plate for all the fibers forms the (negative) image that was recorded in that position of the plate. Simple traverse of the trolley by means of the micrometer screw then shows each of the recorded images, unscrambled, and in proper sequence. One can look at a reconstruction of the event in slow motion, or can copy the images with any convenient camera.

If one looks at the plate, while it is being unscrambled as shown in the lower part of Fig. 6, the visible image is made up of points of varying brightness in a dark field. The average contrast looks more or less normal. If one takes a negative copy of this unscrambled picture, the record is made up of a number of lines of small dark dots (of varying density) in a clear field. The contrast

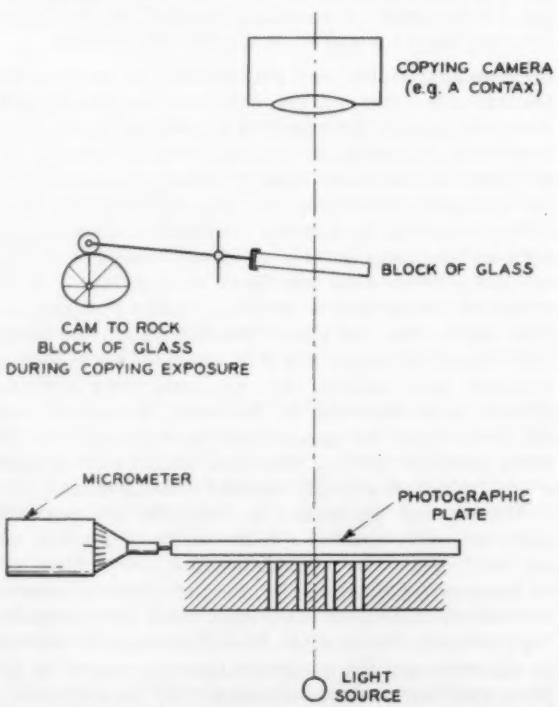


Fig. 6. The experimental arrangement for unscrambling the composite record.

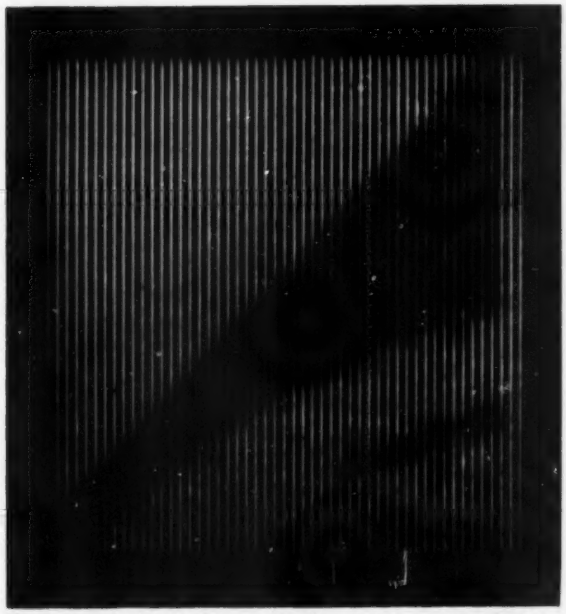


Fig. 7. A typical print from a negative that was a direct photograph of the unscrambled picture.

visually of this copy is very poor, as the negative is, on average, say 90% transmitting even for fully exposed dots. It is also difficult to produce prints of ordinary contrast from such a negative.

One might have defocused the copying camera to blur the dots over the intervening spaces. This, however, was not a good method, since the overall resolution of the picture suffered too much. A better method was to sweep the image across the copying emulsion during the exposure of the copying camera. This was achieved by tilting a block of glass placed in the optical system between the composite plate and the copying camera. The block was tilted by a linear cam. A second, adjustable cam controlled a microswitch to limit the exposure duration and sweep.

This unscrambling technique has been worked out in detail by J. W. McLaughlin, and a more extensive description is published elsewhere.[8] Two of his prints of an unscrambled picture are shown as Figs. 7 and 8. Figure 7 is from a direct copy. For Fig. 8, the optical vernier was used to sweep the image. The improvement in contrast is very noticeable.

I have suggested in the present paper that a fiber optics image dissection camera would be useful for the recording of x-ray images at short intervals. I have described the experimental work which shows that a small scale model optical analogue of equipment can be made to take pictures of 10^5/sec. Dr. F. Früngel and his colleagues[9] have produced x-ray equipment which can be driven by their Strobokin flash equipment to produce flashes of x-rays. The output is about 40 milliroentgens/flash at 20 cm from the tube. They have described the recording of sequences of pictures of 10,000 to 12,000 images/sec using a drum camera for separation of frames. The velocity of the drum was 100 m/sec so that at 10,000 frames/sec the frame height could not be more than 1 cm. The x-ray output per flash is about 10 times the minimum necessary to give a significantly dense record for each flash. Dr. Früngel told me[10] that the equipment will produce a limited series of flashes of x-rays at much higher speed — of the order of 10^5 flashes/sec. Each flash is of the same energy as at the lower frequencies. Any one flash could be expected to record. He asked me if I knew of a method for higher speed recording than his drum camera, particularly for pictures of larger format. It is proposed to try out the scale model fiber optics dissecting camera, using Dr. Früngel's x-ray flash equipment. It is also proposed to make another equipment with a larger fiber optics format, and to test that also as a means of recording repetitive x-ray pictures.

This "Mark II" apparatus will have a format 7 cm by 8 cm and fibers 125 microns diameter at 2000 microns spacing. They will be spaced out in both plan dimensions. If the photographic plate were moved parallel to either of the array directions of the fiber block, one would get double exposures after 16 pictures. If the traverse direction makes an angle of, say, 1 in 5 with the array direction, the plate can move 5 times as far without double exposure. We could thus expect to record 80 pictures in a sequence.†

An even simpler system is in principle possible. Instead of the fiber optics block, one could use a plate made of lead, or of some other suitable material, which would prevent the passage of the x-rays, except through an array of small holes or slits. Just as before, the photographic plate would be placed close behind the dissection plate. A single exposure would produce an x-ray shadowgraph dissected into point, or line, elements. One could obtain the usual intensification of the image by the use of fluorescent or other intensifier foils or screens in intimate contact with the photographic plate.

This scheme is simple, and could work, though the construction of the dissection plate entails many difficulties. The holes in the plate should all point at the

† The fiber block was ground and polished in October, 1960. The various mechanical and pneumatic components of the Mark II camera have been made in early 1961. With the optical analogue, pictures have been taken at 100 kc/sec. More than 60 pictures can be recorded in a sequence. It is hoped that the x-ray testing will be undertaken shortly.

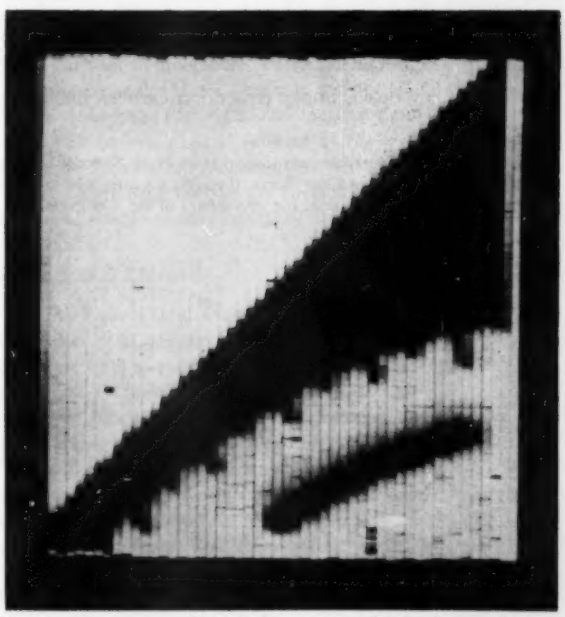


Fig. 8. A typical print of the unscrambled picture from a negative made when the optical vernier was used.

x-ray source. For high energy x-rays, the dissection plate must be quite thick. It would be difficult to form the array of oblique holes. Also, when such an array had once been formed in a dissection plate, that plate could only be used at one working distance from the x-ray source.

For very soft x-rays, almost any obstruction would reduce the photographic effect. It would then be possible to use a very thin sheet or foil, and to perforate it with an array of holes, the axes of all of which were parallel to one another. For example, suppose that the distance from the x-ray source to the dissection plate was one meter. One could use a dissection plate 10 cm square, and $\frac{1}{2}$ mm thick, with an array of holes $\frac{1}{10}$ mm in diameter at $\frac{1}{2}$ mm spacing. The dissected picture would have a resolution of 200 lines by 200 lines. It should be possible to record a sequence of about 20 pictures. The obliquity of the incidence of the x-rays at the edge of the plate would cause some loss in intensity of the recorded image elements, but this should be less than a factor of 2, compared with the intensity of the elements at the center of the plate.

It would be possible to make metal dissection plates, at least for the thinner sheets, by relatively conventional machining, or by etching through a mask.

Another way to make a dissecting plate would involve the use of a photosensitive glass or ceramic such as Corning Fotoform or Fotoceram.[11,12] These materials, where they have been exposed and heat-treated, are ten or twenty times more soluble in a hydrofluoric acid etching bath than where they have not been exposed. It is thus possible to etch holes through material several times thicker than the diameter of the holes. An array of holes with their axes all parallel can be produced by exposure through a mask to a beam of parallel light. Equally, it is possible to produce a convergent array of holes by exposure through the mask with light emanating from a point source. A few experimental dissection plates have been made using a photosensitive glass, but the results with these have not as yet been as encouraging as the dissection systems using fiber optics.

Summary

A small fiber optics image dissection camera has been built. It will take 10 pictures in a sequence at rates up to 10^5/sec using visible light. The camera can be used to unscramble the composite record. It is expected that it will be equally suitable for recording of sequences of x-ray pictures at the same rates, and for subsequent unscrambling of those records. A newer model to take longer sequences on a larger format is under construction and test. Some consideration has also been given to the construction and use of dissection plates made by the simple perforation of suitable materials.

Acknowledgments

I would like to thank J. W. McLaughlin for his extensive help with the details of the unscrambling techniques; A. J. Nardi and J. W. McLaughlin for their measurements of the properties of the fiber optics assemblies; and R. W. Crawford for his measurements of the velocity and acceleration of the pneumatically driven traverse mechanism. In addition, I would like to thank W. P. Siegmund of the American Optical Co. for his help with the manufacture of some of the fiber optics assemblies; and R. F. Saxe of Queen Mary College for advice on certain aspects of the use of fiber optics in x-ray recording.

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12. Corning Glass Works, U.S. Pat. No. 2,628,160; Feb. 10, 1953.

Ed. Note: The Fifth International Congress on High-Speed Photography was sponsored by the SMPTE and supported in part by the Departments of Army, Navy and Air Force through a grant administered by the Chief Signal Officer of the Army. Congress papers and related discussion will be published in the *Proceedings* of the Congress.

news and reports

90th Convention October 1–6 Lake Placid Club, Essex County, N.Y.

Theme: Integration of Motion-Picture and Electronic Systems

ONCE AGAIN an SMPTE Convention will be held in the congenial and relaxing environment of the Lake Placid Club. Those who have attended previous Conventions there will renew their memories of the scenic beauty of northern New York State in the Fall, and for those who will be attending for the first time a Convention at the Lake Placid Club there is in store a memorable experience. At this time of year, according to a report based on past experience, "we will literally have the Lake Placid Club to ourselves" — including two golf courses (9-hole and 18-hole), tennis courts and the waterfront.

Local Arrangements, Eric C. Johnson, Chairman

Local Arrangements Chairmen (listed below), using the magic combination of efficiency and enthusiasm, have completed preliminary plans for making use of all the resources of this famous resort to make the Convention a special experience for all who attend. Readers who have attended previous Conventions (or seen announcements) may sense that there is something different about this listing, and they will be right. The difference is that for the 90th Convention a Golf Tournament Chairman has been appointed.

Papers Program, C. Loren Graham, Chairman

An interim assessment of the Papers Program indicates that the early and energetic approach of the Topic Chairmen (May *Journal*, p. 382) to their assignments has resulted in the assembling of a group of outstanding papers by top-flight authors. A few aspects of the Program may be emphasized now.

There will be a lively session on subscription TV in which representatives of four companies will discuss the engineering aspects of their systems and answer questions from the audience. The moderator will be Gentry Veal of Eastman Kodak Co. A paper on the midwest airborne TV experiment will describe in detail this venture in new techniques in education.

There is also scheduled a paper of general interest on the Abominable Snowman, describing the photographic problems encountered by the Sir Edmond Hillary Expedition on the famous trek undertaken to investigate reports that such a creature existed. A number of papers will describe new equipments, among them a 16mm commercial camera, and two projectors. There are also scheduled some extremely interesting papers on the subject of photography from satellites.

A full session on projection will include the description of a liquid-gate projector for large-screen projection. This projector is reported to keep film cooler, provide steadier film travel and minimize the effect of scratches.

Awards

Presentation of Awards will take place Tuesday evening, as it has during every Fall Convention for several years past. Members who have been chosen to the rank of Fellow and persons whose achievements in the designated category have been duly considered by the Award Committees and the Board of Governors to merit an Award will be honored at that time. Awards that will be presented are: Journal Award, Progress Medal Award, Samuel L. Warner Memorial Award, Herbert T. Kalmus Gold Medal Award, E. I. du Pont Gold Medal Award, and one of the increasingly significant Awards administered by the Society, the Student Member Award.

Rooms and Registration

A Postal Announcement will soon be sent to all members conveying information on accommodations and other relevant practical matters. There will be no advance registration procedure for the Convention but hotel room reservation cards will be mailed to each member. These should be returned direct to Mr. Daniel M. Nelson, Lake Placid Club, Essex County, N.Y. The Lake Placid Club operates on the American Plan, which means that all meals are included in the charge for accommodations. The Registration fee will be $5.00 each for members and $7.50 each for nonmembers. There are numerous motels in the area as well as the Hotel Marcy in the Village of Lake Placid. Meals at the Lake Placid Club for members who are not staying there will be available at rates of $1.75 for breakfast; $3.50, lunch; $4.75, dinner, including tips.

A handy little map of the Club and surrounding grounds will be available at the hospitality desk.

Ladies and Leisure

The Lake Placid Club is a particularly pleasant spot for the ladies. Tea will be served daily and attractive areas are available both indoors and out for playing bridge, reading or conversation. Special activities for the ladies are being planned, including luncheons and trips. Registration for the ladies begins Sunday at 2 P.M. and the $5.00 fee covers the entire week. This will be one Convention where children will not only be welcome but are cordially invited. They need not register and there is no Convention fee for them. It will be a good time to get them acquainted with the workings of the Society.

The emphasis will be on informality. Casual clothes will be appropriate, but it is suggested that sweaters and some woolen garments be included in the luggage because evenings can be very, very chilly. The usual jacket–tie requirement is for dinner

only. Members can be as informal as they please for breakfast and lunch. All Convention guests will be served in the Club's Forest East Dining Room which will be reserved exclusively for Convention registrants and their guests. The Lake Placid Club orchestra will provide background music during dinner.

Entertainment

An Entertainment Ticket priced at $10.00 will cover all types of entertainment arranged for the Convention. All the sports facilities of the Club are available including tennis, boating, swimming and golf. One of the main sports events will be a golf tournament so all golfers are urged to bring their clubs. The round of specially planned entertainment will begin on Sunday evening with a pre-release feature shown for early arrivals in the Lake Placid Club theater. The traditional Wednesday evening fun night will be something different, beginning with the cocktail party where all guests are told to wear an "original" costume. Following the dinner there will be dancing until midnight and prizes will be given for the most original and the funniest costumes. Thursday evening is set aside for a Treasure Hunt and a Clam Bake.

Convention Planners

Local Arrangements Chairman, *Eric C. Johnson*
Vice-Chairman, *Arthur J. Miller*
Motion-Picture Shorts and Features, *George Keene*
Projection, Public Address and Recording, *E. B. Hall*
Hotel Arrangements, *Irving M. Ewig*
Registration Chairman, *Charles F. Lo Balbo*
Auditor, *George H. Gordon*
Get-Together Luncheon, *Saul Jeffee*
Banquet and Awards Session, *Byron Roudabush*
Entertainment Chairman, *Joseph Dougherty*
Golf Tournament, *Kenneth M. Mason*
Hospitality and Ladies Committee
Chairman, *Louis Feldman*
Co-hostesses, *Mrs. Eric C. Johnson*
Mrs. Arthur J. Miller
Mrs. Louis Feldman
Administrative Assistants, *John J. Kowalak*
William H. Metzger
Membership Chairman, *Robert Burns*
Publicity, *Standish Holmes* and *Barbara Skeeter*

Education, Industry News

Films for Students of Physics, by Robert L. Weber, Assoc. Professor of Physics, Pennsylvania State University, University Park, Pa., was published in the April 1961 issue of the *American Journal of Physics* (pp. 222–233). About 450 films, helpful for instruction in physics, mostly at college level, are listed. The films, grouped in ten categories, are predominantly 16mm in sound black-and-white, although a number are in color and a few are available either way. The categories are Introductory and General, History and Biography, Astronomy, Meteorology, Mechanics, Heat and Thermodynamics, Sound Electricity and Magnetism, Light, Atomic and Nuclear Physics, Solid State Physics. Professor Weber is now at work on Supplement I and plans to add the category of Rockets, Satellites and Space. So that Supplement I will bring the list entirely up to date, he has requested that anyone who can recommend a suitable film or make such a film available for classroom use supply him with information including: exact title; running time; data of production or release; information as to accompanying study guides, manuals or transcript, if available; name of producer and/or sponsoring organization; and the name and address of the organization to which inquiries about purchase or rental of the films should be listed.

Williamsburg — The Story of a Patriot, a 37-minute color film produced by Paramount Pictures Corp. for Colonial Williamsburg, Inc., has been honored by the *Scholastic Teacher* in the 12th annual National Film and Filmstrip Awards program conducted by the magazine. Cited as an outstanding secondary film in the social studies category, it became eligible for consideration under this program in 1960 when the film, released in 35mm in 1957, was made available for classroom use in 16mm. Produced in VistaVision with Todd-AO stereophonic sound, and shown daily in Colonial Williamsburg's twin theaters, the film has been seen by more than two million persons since April 1957. This film is also used by the Defense Department's Office of Information and Education for its Troop Information Program.

Temac, a teaching technique, essentially a system of programmed learning materials designed for self-instruction under controlled classroom conditions and introduced by Encyclopedia Britannica Films, 1150 Wilmette Ave., Wilmette, Ill., has influenced and been influenced by the modern, scientific approach to the use of films, slides and other audio-visual materials in teaching/learning activites on all educational levels. The first report on Temac was issued by Encyclopedia Britannica Films in 1960 and Report No. 2 is now published. After Report No. 1, a program of controlled testing of Temac mathematics materials was undertaken in Roanoke, Virginia, high schools, with 900 students participating. Report No. 2 sums up the results of this test (grades of students in the Temac program significantly higher than those of a comparable group taught by conventional methods) and outlines further developments and plans. A number of additional courses in language and mathematics are soon to be made available.

The 4th UNIATEC Congress (International Union of the Cinematographic Technical Associations) will be held in Torino, Italy, September 24–27, 1961, under the auspices of the 11th Salone Internazionala Della Tecnica and the Associazione Tecnia Italiana per la Cinematografia (ATIC). The theme of the congress will be "Evolution and Orientation of Cinematographic Techniques With Reference to the Fundamental Scientific Principles." The second International Concourse of Films will also be held in connection with the congress. Among the papers scheduled for presentation is "The Influence of Recent Scientific Discoveries on the Future of Cinematographic Technique," by Prof. Jahoda of Czechoslovakia. The paper will survey present trends and will discuss possible future developments with emphasis on data recording. Information on the congress is available from Secretariat of the Salone Internazionale Della Tecnica, corso Galileo Ferraris 60, Torino, Italy.

Newly elected officers for 1961–62 of the Industry Film Producers Association, 6085 Sunset Blvd., Hollywood 28, are: *President*, Raymond E. Fielding of the University of California, Los Angeles; *Executive Vice-President*, Carl N. Brewster, Aerospace Corp.; *Financial Vice President and Treasurer*, Ed Hunter, North American Aviation; *Editorial Vice-President*, Jack R. Gabrielson, Douglas Aircraft Co.; *Chapter Vice-President*, Ralph Hall, Convair; *Secretary*, Justin M. Purchin, Systems Development Corp.; *Convention Vice-President*, Tony Gorsline, Aeronutronics. The IFPA was founded in 1957. The membership of over 400 includes motion-picture producers, cameramen, writers, directors, film editors, supervisors, sound men, animators and supporting technical specialists. In addition to the Los Angeles group, there are Chapters at Cape Canaveral, Fla., New York, and Marieta (Atlanta), Ga.

The Instrument Society of America will hold its 16th Annual Instrument-Automation Conference and Exhibit September 11–15, in Los Angeles. Sessions will be in the Biltmore Hotel and the Exhibit in the Memorial Sports Arena. Theme of the Conference is "Reliable Information From Under Water to Outer Space." Organizations cooperating with ISA by arranging and presenting special sessions include American Chemical Society, American Meteorological Society, California Natural Gas Association, IRE, Precision Measurements Association, Professional Group on

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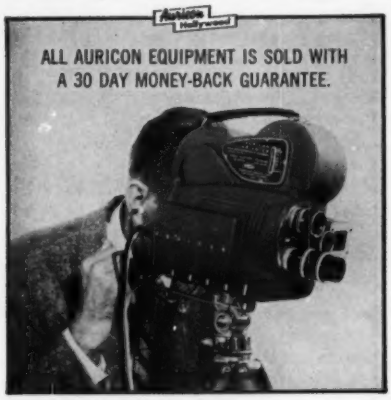

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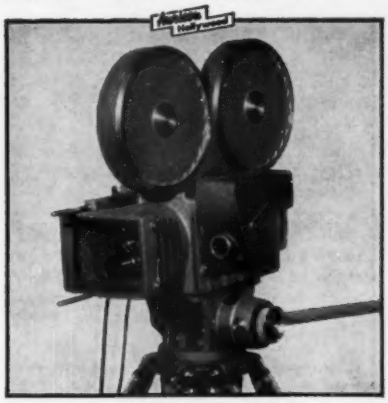

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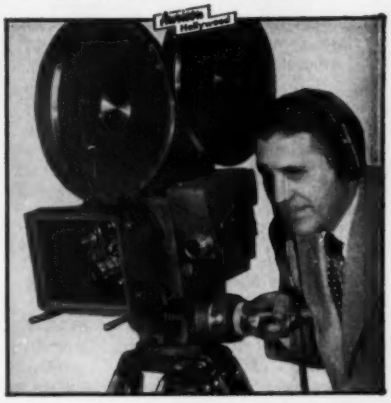

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Reliability and Control, Southern California Metering Association, and Temperature Measurement Society.

The North Atlantic Region of the American Society of Photogrammetry will hold its Semiannual Convention October 4–6, at the Biltmore Hotel, New York. Papers now scheduled will discuss the more exotic aspects of photogrammetry as well as the latest developments and advances in the basic engineering applications of photogrammetric principles. Chairman of publicity is Leo Eichin, Autometric Corp., 331 W. 44 St., New York 36.

SMPTE President John W. Servies spoke before the Annual Meeting of the New York State Association of Projectionists on May 24. His address stressed the importance to projectionists of affiliating with a professional organization, such as this Society, and thus enjoying ready access to the latest developments in projection. He also stressed the special help given by the Society in working toward solutions of special projection problems on a technical level, and the importance to the projectionist as an individual of participating in Society activities.

Marty R. Young has been appointed Director of Live Photography and Business-Industrial Films for Keitz & Herndon, Inc., 3601 Oak Grove, Dallas, Tex. For the last two years he has been Executive Vice-President and General Manager of the Dallas firm, Motion Pictures, Inc. He has produced and directed a number of award-winning films shown at the American and the Columbus Film Festivals. According to the announcement, Mr. Young's appointment was part of the firm's expansion program in the fields of business, educational and public relations films.

William Weitzen, former Deputy Assistant Secretary of the Air Force for Development, has been appointed Regional Vice-President, Washington, D.C., Area Operations of Autometric Corp., 1501 Broadway, New York 36. Announcement was made by Paul Raibourn, President of Autometric. While in the Air Force, Mr. Wetzen's work was chiefly directing, evaluating and coordinating programs and policies in the area of military weapons systems, supporting systems, technical developments and applied research. Activities in his present post will be in the fields of data reconnaissance, mapping and charting geodetic studies, and various advanced space projects.

Boyce Nemec, Executive Vice-President of Reevesound Company, Inc., Long Island City, N.Y., and former Executive Secretary of this Society, has been appointed to the Board of Managers of the New York Section for a two-year term. He succeeds Peter Keane, Technical Director of Screen Gems, Inc., who has been appointed Secretary-Treasurer of the New York Section.

Forrest Richey has been appointed assistant division head of the Color Photography Div., Kodak Research Laboratories. He joined the Kodak Part Works in 1939 as a member of the Motion Picture Film Processing Dept. He transferred in 1944 to the Photography Div. and in 1960 he was appointed Senior Research Associate. Other new appointments announced by Eastman Kodak Co. include Scheuring S. Fierke, assistant division head, Emulsion Research Div.; Howard E. Munro, assistant superintendent, Synthetic Chemicals Div.; and Carl W. Zuehlke, assistant division head, Chemistry Div.

George L. Oakley has been appointed Director of Sales of the Photo Products Div., Bell & Howell, 7100 McCormick Rd., Chicago 45. He has been with Bell & Howell since 1946 and has been Director of Audio-Visual Sales since 1958. In his new position he is successor to George A. Eddy who has been appointed Director of Amateur Film Operations.

J. R. Poppele has been appointed a Director of Foto-Video Electronics, Inc., 36 Commerce Rd., Ceder Grove, N.J. For more than 20 years he was Chief Engineer for Radio Station WOR, and later as Station Vice-President and Director of Mutual Broadcasting System he was in charge of all AM, FM, TV and facsimile projects for General Teleradio, Inc. Prior to his present appointment he was Director and Consultant to the Board of Advisors of the Voice of America. He is presently serving as a member of the Committee on Civil Defense Planning under the office of the Secretary of Defense; President of the Atom Broadcasting Corp., and WAUB, Auburn, N.Y.; and Board Member of the Teleglobe System of Pay TV and General Electronics.

Lt. Col. Harry Brodsky (Air Force Reserve) has accepted an appointment by S.O.S. Photo-Cine-Optics, Inc., to act as supervisor of the firm's newly expanded Rental and Leasing Dept. Col. Brodsky has had considerable experience both as photographer and production consultant in both military and civilian capacities. He was recently associated with Mark Shaw Studios in New York.

Burton Stone has been appointed Sales Manager of Movielab Film Laboratories, Inc., 619 W. 54 St., New York 19. His previous posts include General Manager for Consolidated Film Industries, Eastern Division, and Director of Technical Operations for a New York advertising agency.

Biographical Notes

Kern Moyse

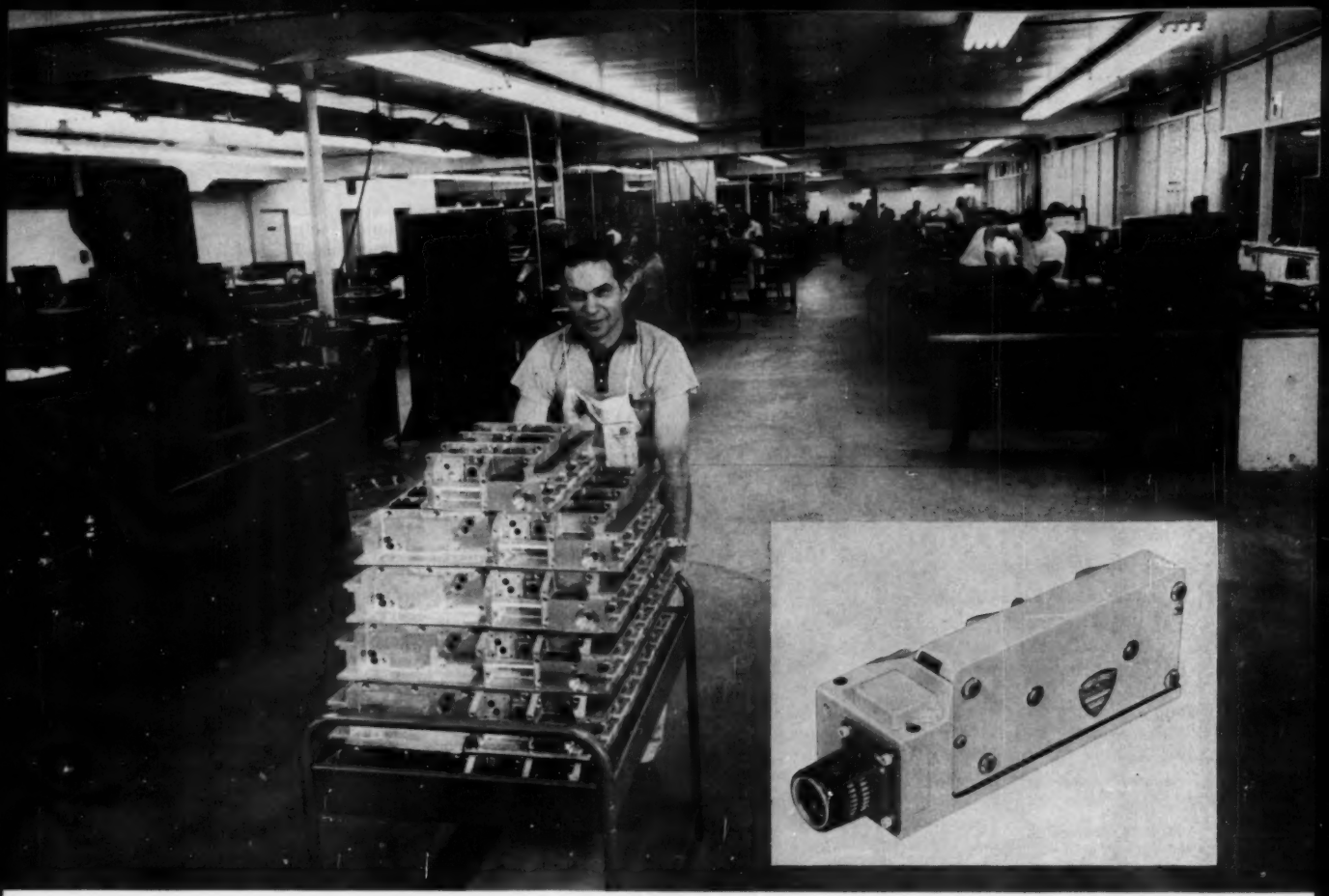
Kern Moyse has announced his retirement after 15 years as President of Peerless Film Processing Corporation, and 27 years with the company. He plans to spend most of his time at his home in Old Lyme, Conn.

While President of Peerless Mr. Moyse was active in various industry organizations. He was one of the founders of The Association of Cinema Laboratories and from its inception Chairman of the Membership and Admissions Committee. He was for several years a Director and for the past three years Treasurer. He was also a founder of the Motion Picture Industry Group of the National Association of Credit Management, a member of its executive council for several years, Vice-Chairman for two years and Chairman for two years. He was Treasurer of the New York Film Council for two years, and Chairman of the Insurance Committee of the Radio and Television Executives Society for three years. He is a member of the Society of Motion Picture and Television Engineers and the Motion Picture Pioneers and a number of organizations concerned with industrial, educational and biological film.

Peerless had its real beginnings in 1924, when Victor A. Stewart, an Australian living in New York, applied for a patent on a treatment of developed motion-picture film by means of gases to convert the colloid substance of emulsion into an insoluble compound, in order to eliminate damage from moisture and to reduce susceptibility to damage from other sources. The patent was issued in 1926, and Film Life Extension Corp., subsequently called Stewart Film Process Co., was formed. In 1929 Edward Moyse acquired control of the company. Under his direction the Stewart Process aroused widespread interest because "green," freshly processed film was then presenting critical problems for projection. The effectiveness of the process in reducing these difficulties was well recognized, but the time required for treating release prints in quantity was an obstacle to extensive acceptance.

In 1933 Victor C. Krupa, then supervisor of negative assembly at Consolidated Film Industries in Fort Lee, N.J., developed for Mr. Moyse a process for applying a similar gas treatment in a high vacuum. This enabled utilization of larger and more versatile equipment, which could by reason of the vacuum operation accomplish more effective treatment and also could produce volume results.

Peerless Film Processing Corp. was organized in early 1934, with Edward Moyse as President, to acquire the Stewart company and Mr. Krupa's applications for patents, which were subsequently granted. Within a year Peerless Treatment was adopted for the releases of Twentieth Century-Fox, United Artists and Columbia Pictures. Leading producers, industrial corporations and government agencies interested in the growing 16mm field also



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The 16mm-1B camera offers film capacities of 100, 200, 400, or 1,200 feet. More than 30 lenses are available to fit it, from 165° super wide-angle to 24-inch focal length. It has a variable shutter behind the prism to give sharpness and motion-stopping ability like you've never seen before. Let us show you one of these comers tomorrow. It's the BEST high speed camera in the world!

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began to use what was sometimes called Peerless Vaporate Film Treatment or, more simply, "vaporating."

On Mr. Moyse's death in 1946 his son, Kern Moyse, who had been Vice-President and legal counsel since the company's inception, became President. Although Kern Moyse had not been too active in the operational phases of Peerless, he had a broad business background to apply to its development. After graduation from Harvard and two years as an infantry machine gun officer in World War I, he first worked as field scout for an oil pipeline company in Texas, then in a New York bank. He spent some time in Cuba as Treasurer and Managing Director of a coal company, and later was appointed as Treasurer and legal counsel of a roofing manufacturer. For 11 years he was active as an insurance agent and broker. He served in the Army again for 4½ years in World War II and was on terminal leave when he became President of Peerless.

Victor Krupa, a film technician for 25 years, who had been on leave from Peerless as laboratory coordinator and West Coast production supervisor for Soundies Distributing Corp., returned to Peerless in 1947 as Vice-President and Technical Director.

Together Kern Moyse and Victor Krupa, who had long been close friends, worked toward expanding the potential usefulness of Peerless to the industry. A West Coast Branch was established in Hollywood, under the management of Mr. Krupa. Machines for Peerless Treatment were installed in a number of additional laboratories, until there were some twenty installations in the United States and installations in Canada, Mexico, England, Belgium, Holland, Switzerland, Spain and Australia. To meet varying laboratory and industry requirements, models of different capacities were developed, ranging from small portable units to machines which could treat 60,000 ft of 35mm or 120,000 ft of 16mm per hour and a machine for treatment of Cinerama and other oversize reels up to 10,000 ft. The chemicals were also progressively improved by developments for more effective performance and by research leading to the elimination of the problem of toxicity.

Besides protection of prints for standard projection, Mr. Krupa's interests led him in 1939 to develop a treatment for prints to be shown in continuous projectors. Besides inventing a radically improved method of treating such prints, there was also developed a process for protecting original and other pre-print material against damage during printing and shrinking during storage. In the past twelve years the firm's film conservation activities have also included restoring release prints suffering from brittleness, shrinkage and bad splices, or salvaging original footage.

In 1949 Mr. Krupa invented a process to correct excessively shrunken pre-print material and permit its safe passage through continuous printers to print without distortion of image and sound. Other processes developed by Peerless include RH treatment for brittleness, buckle and curl; and Hydrex for variously restoring film subjected to water immersion. The firm has also an extensive reconditioning operation for the amelioration of the effect of scratches on either the emulsion or celluloid support side.

Peerless began in the early 1950's under Mr. Krupa, a pioneer distribution service of television shows on film, including the preparation of pre-print material, evaluation of print quality, insertion and excision of commercials, shipment, inspection and repair of prints. Also, film libraries are operated for industrial corporations and nonprofit organizations.

Although a decision as to a successor to Mr. Moyse is yet to be made by the Board of Directors, no changes in the policies of Peerless or its operation are contemplated. Mr. Krupa will continue as Vice-President in charge of all its operations on the West Coast, and as Technical Director. Barbara Holz will continue as Treasurer, and Suzon Steinle Krupa as Secretary. Raoul J. Menendez, who as sales manager has worked closely with Mr. Moyse in building up the extensive clientele of Peerless for reconditioning and library services, has been appointed Vice-President in charge of sales promotion and public relations. Stanley Cohen has also been appointed Vice-President and will continue in charge of New York operations. These officers have an average service of over 15 years with the firm and they expect to continue its usefulness to the industry.

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Clyde R. Keith

Clyde R. Keith, internationally known authority on sound recording, retired February 1, 1961, from Bell Telephone Laboratories. Following his retirement, the United Presbyterian Church announced that Mr. Keith had accepted an appointment as Assistant Director of Audio Visuals of the Board of National Missions. For about ten years prior to this appointment he has acted as a volunteer aid to the Board.

Mr. Keith began his career in Bell Telephone Laboratories in 1922, following graduation from the California Institute of Technology. In 1928 he joined Metro-Goldwyn-Mayer Studios in New York, and the following year he joined Western Electric, Ltd. in London. Between 1929 and 1935 he was chiefly engaged in installing sound recording systems. In 1935 he returned to the United States where he continued in sound recording activities for Electrical Research Products, Inc., and later for the Electrical Research Products Division of Western Electric. He returned to Bell Telephone Laboratories in 1951, where he was engaged until retirement in the design of telephone answering and announcement machines. He holds a number of patents both in the United States and abroad for his sound recording inventions.

A Fellow of the Society, Mr. Keith is the author of numerous scientific papers, many of which have been published in the *Journal*. For many years he has been active in Society affairs. He served as Editorial Vice-President from 1947 through 1950, and for many years, beginning in 1943, he served (and still serves) on the Board of Editors. His statement on the Editorial Policies of the *Journal* (May 1949, pp. 578–579) is still a model of exactitude and conciseness.

Among other Society activities, he has served as General Secretary (1946), Atlantic Coast Chairman (1945), and also as a member of the Papers Committee.

Among his many papers which have appeared in the *Journal* is: (with V. Pagliarulo) "Direct Positive Variable-Density Recording With the Light Valve," June 1949, pp. 690–698.

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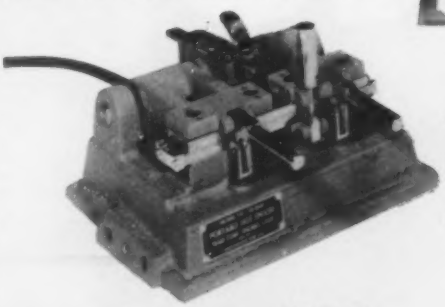

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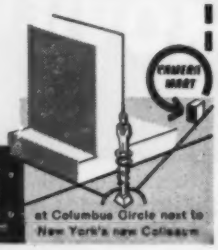

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Ray Jerome Baker

Ray Jerome Baker, a photographer who is now 81 years young, has spent about 60 years of an exciting life in the triple role of professional photographer, author and lecturer, and for 33 of these years he has been a member of the SMPTE. His main interest has been photography, and his first excursion into that field took place in 1901. During that year he acquired a 4 × 5 Premo plate camera. Part of the year 1903 was spent in the harvest fields of Nebraska and North Dakota, and during that same year, he engaged in portrait photography in Forsyth, Montana. His studio was a tent; his patrons, "sheepherders and railway men," he recalls.

The year 1908 was an important one for Mr. Baker. In January of that year, he and his wife went on a honeymoon trip to Hawaii. The trip, which was to have lasted two weeks, was extended somewhat beyond the original plans. The couple decided to settle in Hawaii, where Mr. Baker still resides. His present address is 1348 Tenth Avenue, Honolulu.

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Baker's outfit for making industrial motion pictures in sugar mills in Hawaii, taken around 30 years ago.

culture, about which he has lectured and written—is impressive, and his lively recollections of events seen by him and his camera convey a vivid impression of "how it really was." For example, in 1918, there was a heavy eruption of Kilauea Volcano, and Mr. Baker was right there on the rim, pointing his motion-picture camera down at the glowing, writhing lava. Years later this film was still being shown. That same year he filmed the funeral of Queen Liliuokalani. He used a Burke & James Universal Camera and tripod which he had purchased about 1912 for "an overall price of about $350." This camera was later (about 1956) presented by Mr. Baker to the George Eastman House, Rochester, N.Y., along with two other early motion-picture cameras, a French DeBrie and a French Gaumont (all 35mm).

About 1926, Mr. Baker became intensely interested in time-lapse photography. Much of his equipment was "home-made," and various ingenious devices were built and methods devised for the new photographic venture. The germination of seeds, always a fascinating subject to gardeners, botanists, and also to the general public, was the subject of one of the films, which he said was "divided into two main parts, monocotyledons and dicotyledons." This picture, he said, "took more than a month to make." The seeds were placed in a glass-sided sand box, and a backing of black paper placed behind the seeds in front of the sand. The box was placed in a shallow pan of water and the sand kept moist. Exposures were made at four-minute intervals, and the camera was kept running continuously for whatever time was required. A phonograph motor was used to run the camera and an ingenious arrangement of pulleys and belts was used to slow the speed to the required interval. Between 1926 and 1929, Mr. Baker made a number of interesting time-lapse studies of protozoa, acquiring for this purpose a high-powered microscope.

His growing interest in scientific photography led him to a resolve to acquire more academic knowledge so in 1929 he matriculated in the University of Hawaii, and in 1934 was graduated with the degree of Bachelor of Science. During that time he continued his work in photography.

The summer of 1949 inaugurated a decade of travel, from Mexico to Alaska, through the West Indies, Central America, Europe, Egypt, the Near East, and the Far East, then north to Norway, Finland and the Soviet Union, and south to New Zealand. He visited more than 56 countries, all the while making motion pictures, usually 16mm.

He describes 1959, 1960 and 1961 as "Retirement Years," but he seems to be engaged in many activities and to be as alertly interested in contemporary developments as he was 60 years ago at the beginning of his career.

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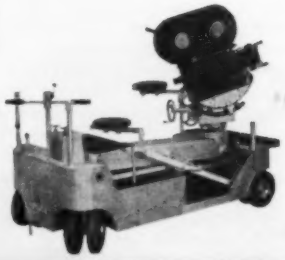

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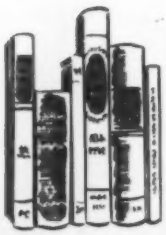

books reviewed

Magnetic Tape Recording

By H. G. M. Spratt. Published (1958) by The Macmillan Co., 60 Fifth Ave., New York 11. 319 pp. incl. indexes and apprendixes. Illus., graphs. 6¼ by 8½-in. Price $8.50.

The breadth of coverage by this comparatively small book is quite surprising. In covering such a wide subject area the author has of necessity treated some of the items with dignified brevity. However, this reviewer did not find such brevity to be of any detriment, and that the author is thoroughly versed in the various aspects of tape recording there can be no doubt.

Approximately the first third of the book is devoted to the subjects of Principles of Magnetism, Sound Reproduction and Electro-Acoustics, and Principles of Magnetic Recording. A number of readers will undoubtedly find the first two chapters of the text to be quite elementary. A very brief chapter on Tape Manufacturing Materials is followed by a thorough chapter on the methods and problems of magnetic-tape manufacture, followed in turn by thirty-odd pages of detailed description on the subject of tape testing.

In Chapter 7 (Tape Recording Machines), the author makes some thought-provoking observations, to wit: "The design of tape recording equipment falls naturally under two headings: the electronic circuits and the transport mechanism or mechanical drive. Of the two, the mechanical design is by far the more exacting. Apart from the heads, which have both mechanical and electronic features, the circuits generally follow established practice which in the main differs only to a small degree from the standardized technique in sound engineering. Furthermore, it is not a subject where, by the exercise of outstanding ingenuity, appreciable economies in any particular direction are likely to be effected. As regards the mechanical drive the situation is entirely different. Constancy of drive and starting and stopping requirements, coupled with the fragile nature of the recording medium, call for skilled design of the highest order backed by first-class workmanship. At the same time the established techniques of the kindred subjects, disk recording and cine-film projection, can be applied only to a limited extent, and then with considerable reserve. Finally, in a sense, the mechanical design is the more important of the two since faulty circuits can frequently be corrected without difficulty whereas mechanical weaknesses often demand complete redesign."

This reviewer has not previously seen this point of view expressed so eloquently, in fact does not recall having heretofore seen it expressed in the literature at all. Although such a point of view might cause some raised eyebrows in some strictly electronic circles, that such is in fact true will probably be attested to by all those engineers who have an appreciation for the total overall problems of tape-recorder design. This chapter also includes a number of illustrations and circuit diagrams, covering the studio and portable versions of the professional-type machine, plus the domestic type units. Various parts of the transport mechanism and the electronic circuitry are discussed from the design requirement viewpoint.

Chapter 8 contains many illustrations of commercially manufactured machines, including office dictating machines. Chapters 9 through 12 cover the subjects of Testing Machines, Application of Magnetic Recording, Present Trends and New Developments, and Recording Standardization. The appendixes continue with standardization covering such items as: dimensions of the tape, tape spools — both European and NAB; NAB hub, adapters, tape speed, reel rotation, recording and reproducing characteristics. The problems of abnormal climatic effects are discussed briefly but adequately in Appendix II; Appendix III contains a brief discussion of the basic electrical design of the reproducing head.

All in all an informative book, strictly British with a few exceptions — which may limit its usefulness to the American engineer — but a book with numerous gems of specific information to be gleaned therefrom.—*R. A. White*, GPL Div., General Precision, Inc., Pleasantville, N.Y.

The Physics of Television

By Donald G. Fink and David M. Lutyens. Published (1960) by Anchor Books, Doubleday & Co., Garden City, N.Y. 160 pp. incl. index. Illus. Diagrams. Paperbound. 4 by 7½-in. Price 95 cents.

This little book is one in the science study series written with the avowed purpose of fostering the interest of young students and of laymen in science. It is this reviewer's opinion that several of the books in this series will have precisely this effect. However, the effect of *The Physics of Television* is less easy to predict (possibly because your reviewer is a conservative engineer at heart).

As engineers we all know that in a television system light reflected from a scene is imaged by a lens on a photo-cathode in a camera tube; that by scanning with an electron beam the charge image is converted to a current varying with time; that this varying current is broadcast to distant points through its use to modulate a carrier and through the subsequent demodulation of the carrier; and that a replica of the original image in the camera is produced by scanning over a phosphor with an electron beam, the strength of which is varied by the demodulated signal current. Fink and Lutyens have described these

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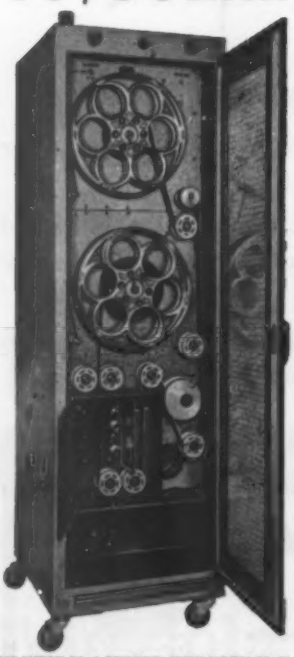

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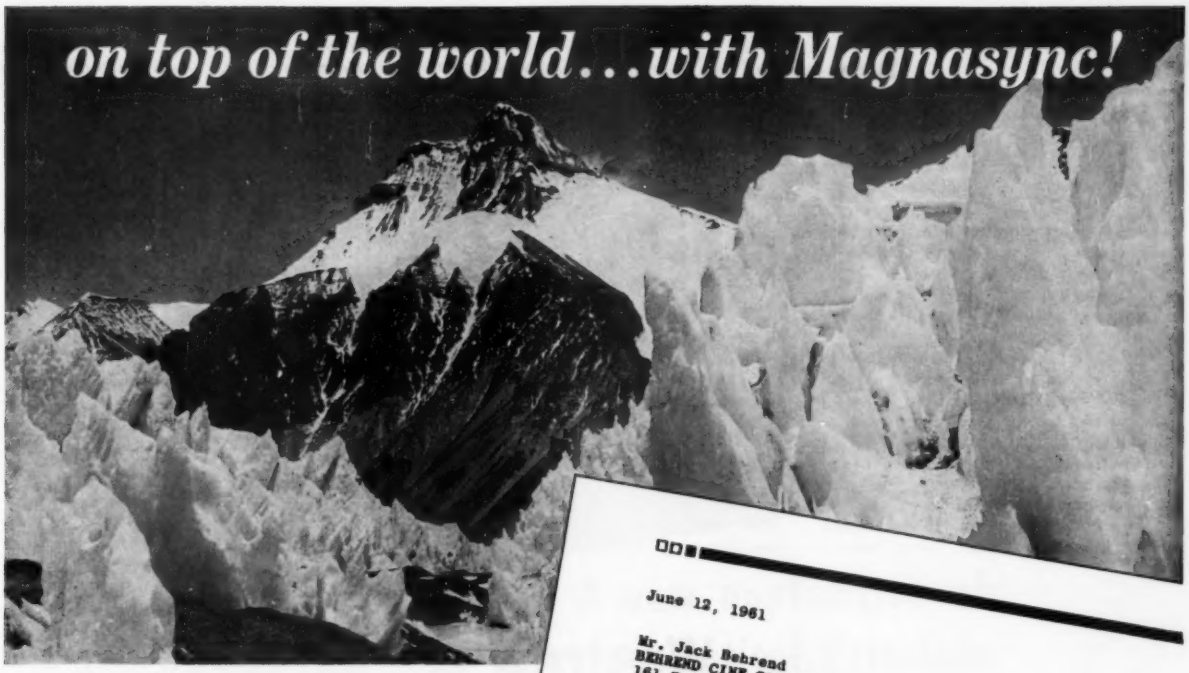

Following his recent tour that led him into the towering Himalayas with Sir Edmund Hillary's "Abominable Snowman" search party, Fred Niles had this to say about the Magnasync Nomad recorder/reproducer.....

June 12, 1961

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As you know, I recently returned from a world trip where we made three pictures -- one for the Care people, one for Lions and, of course, the prime reason for our assignment, shooting in Katmandu, Nepal for the expedition of Sir Edmund Hillary to the Himalayas in search of the Snowman.

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Fred A. Niles

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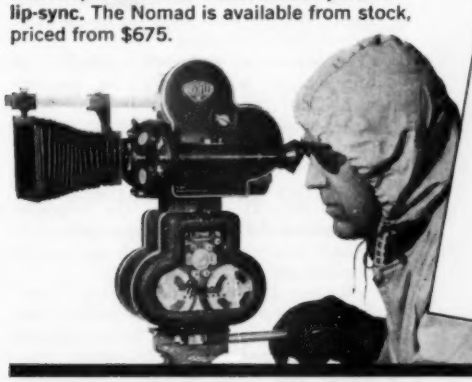

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processes in a very able manner from a very different point of view.

In their treatment Fink and Lutyens discuss each part of a television system from the point of view of a theoretical physicist. The light falling on a scene is emitted in quanta as a result of the change of energy of atoms from an excited state to the ground state. Similarly the absorption and reflection of light from each element of a scene is discussed in terms of energy transitions within the atoms which make up the objects in the scene. And the remainder of a television system is treated in this same manner.

Within this framework, Fink and Lutyens have produced a very readable and interesting text. The television engineer will find the approach refreshing and enlightening. The physicist, however, will be hard put to learn much from the book.

This reviewer is disturbed by the effect this book may have on the naive audience for which it is intended. If its reading arouses his curiosity and drives him to standard texts — well and good. But the naive reader cannot expect that this book will serve as a background for fruitful discussion either with television engineers or theoretical physicists.—*W. T. Wintringham*, Bell Telephone Laboratories, Murray Hill, N.J.

Conductance Design of Active Circuits

By Keats A. Pullen, Jr. Published (1959) by John F. Rider Publisher, Inc., 116 W. 14 St., New York 11. 330 + xiii pages, 6 by 9-in. Price $9.95.

This book is the first textbook published on the use of conductance curves for designing active circuits (both vacuum tube and transistor). The author has been engaged for a number of years in attempts to convince engineers that the use of conductance curves is simpler and more precise than the present concepts. In line with these attempts, triode curves show the plate conductance and transconductance, and gain is found by a formula adapted to the use of these curves. However, the common formula for the gain of a triode amplifier (i.e., gain = $\mu R_L/(r_P + R_L)$ is simpler to use with the data generally supplied by manufacturers. The conductance formula for the gain of a cathode follower is, similarly, somewhat more difficult to use.

In the case of transistors, the g-parameters are perhaps more common; however, most data supplied by the manufacturers make use of the hybrid parameters, thus requiring conversion if conductance principles are to be utilized in circuit design.

The book is well written and informative, and represents a useful addition to a design engineer's library if the user realizes that other methods not only exist but, in many cases, are simpler. With this realization, the conductance design principles form a valuable addition to an engineer's background. The introduction to conductance and the description of the relation between conductance and the more conventional parameters is simple and easily comprehended, and engineers should have no trouble in following the flow of information. In this respect, the book is informative and useful, and represents a worthwhile addition to a library.—*H. W. Mertz*, Haddonfield, N.J.

Basics of Missile Guidance and Space Techniques

By Marvin Hobbs. Published (1959) by John F. Rider Publisher, Inc., 116 W. 14 St., New York 11. 2 Volumes, 144 pp. and 146 pp., 6 by 9-in. Price $7.80 per set.

This pair of volumes (a single volume in the hard-cover edition) is another in the series of Rider publications which are well known for their simplicity and profuse illustrations. This particular book was prepared as a comprehensive basic course in the field of missile guidance and related space systems for both technical and semitechnical personnel.

In Volume I, the author provides an introduction to guidance, its requirements, and the techniques used to satisfy these requirements. The specific systems cited as examples are not by any means new, but are primarily German systems in use or development at the end of World War II. However, the principles exemplified by these systems also apply to more modern systems which may be of a classified nature.

Volume II, also in the "picture book" style common to many Rider publications, discusses space techniques from a general viewpoint, and covers telemetry, electronics and optics in space exploration, various aspects of man-made satellite systems, and electronic components. As in the first volume, the systems cited as examples are not new, but many are still in use. For example, the chapter devoted to electronics and optics in space exploration is primarily concerned with astronomy — both optical and radio — but is quite limited in scope and does not include some of the newer uses of radar in astronomy, such as in the calculation of solar parallax (used as a yardstick for solar system distances).

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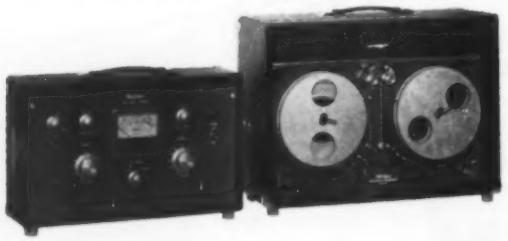

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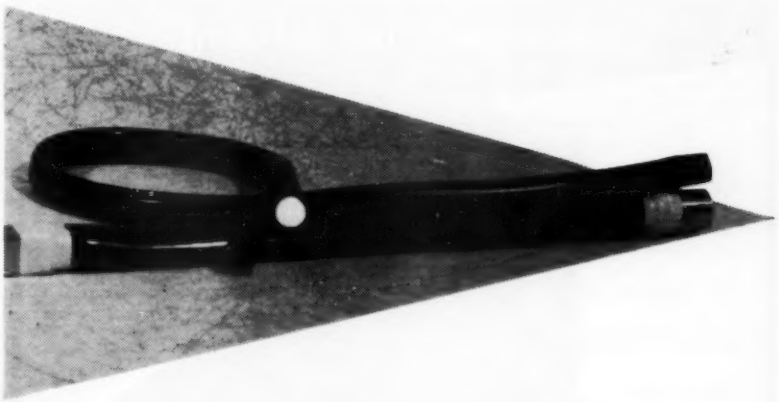
A Technical Paper on Fiber Optics Printing was given on May 12, 1961, at the SMPTE Convention, Toronto, Canada, by A. J. Miller, Vice Pres., Du Art Film Labs & Tri Art Color Corp. Copies are available on request.



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For the engineer working in the fields of either missile photography or television, the book falls short. For these people, a treatment of such topics as satellite stabilization systems; satellite-borne television, infrared, and optical systems; and relay systems for information transfer would be far more desirable. However, for the person desiring an introduction to the field of guidance and space systems — whether he be engineer, technician or schoolboy — the book fulfills the need for a simplified but accurate presentation. It should, therefore be considered primarily as an informative and interesting addition to a personal or company library, but not one which is likely to be of direct use.—*Harvey W. Mertz*, Haddonfield, N.J.

International Transistor Substitution Guidebook

By Keats A. Pullen, Jr. Published (1961) by John F. Rider Publisher, Inc., 116 W. 14 St., New York 11. 56 + viii pp. Diagrams. 8¾ by 5½-in. Paperbound Price $1.50.

Original transistors and corresponding electrical substitutes are tabulated by type numbers. Mechanical differences in case sizes and styles are called out where sufficient to hinder substitution. Dimensions and shapes are shown for all types. Scope of listings is worldwide.—*B. D. Plakun*, GPL Division, General Precision, Inc., Pleasantville, N.Y.

The Technique of Optical Instrument Design

By R. J. Bracey. Published (1960) by English Universities Press Ltd., 102 Newgate St., London, E.C.1, England. 316 pp. incl. index. Diagrams. 5½ by 8½ in. Price 35 shillings.

It is not often nowadays that one finds practical technical details of optical instrument design described in a book. One finds theory, yes, but there is little of an advanced nature on how the theory is used effectively. In part it is because this art is understandably jealous of its trade secrets. In part, however, it is also because of the great complexity of the subject, making of it really an art rather than a science.

Mr. Bracey holds a number of distinctions, among which is having been head of the Optical Department of the British Scientific Instrument Research Association. He analyzes the technique of optical design in three steps: (1) instrument design according to Gaussian optics; (2) instrument design according to third order aberrations; and (3) instrument design adjusted by a trigonometrical survey.

He says, "This last stage in which exact calculations are made, inevitably reflects the personality and available equipment both mental and mechanical of the computer... The individual genius of the computer now becomes apparent in the handling of technical details and the classical scheme is, or should be, merely used as a foundation on which to build appropriately according to one's resources." This is an excellent description of an art. Although the author gives much interesting and useful information on the nature of these "technical details" he does not really betray any deep secrets.

The organization of the book is not wholly around the three steps listed, but they do form a convenient grouping for review.

Mr. Bracey covers his first step in some detail, with thin and thick lenses, and the use of ray traces, including skew rays. For a second part of the first step the author covers chromatic aberrations. He starts with classical achromatic lenses (corrected at two wavelengths) and then goes on to apochromats (corrected at three wavelengths). He indicates the advantages of fluorite glasses, permitting better color correction, yet with the use of lens surfaces of less curvature. The book has been published too soon to note Herzberger's technique of "superchromatisation," where the lens is made practically color-free throughout the visible spectrum by designing with four-parameter analytic dispersion functions for the glasses used.

Mr. Bracey's second step is also treated in some detail. This is a rather lengthy subject, starting with axial aberrations and ending with the analysis and control of the general field aberrations.

By the term "trigonometrical survey" in his third step the author means a precisely calculated ray tracing analysis. He enters this third step by easy stages, starting with the design of eyepieces. Here he indicates final touches to improve the performance of more elementary designs. His last illustration of the third step is the design of photographic objectives, and at this point the reader can hardly expect instructions for a highly sophisticated design. The author follows through a symmetrical, or nearly symmetrical, triplet. With an additional step that he mentions but does not consider in detail this becomes the Tessar. The author concludes this illustration with the statements, "These remarks will have served to outline briefly the extensive field which lies before the designer. The methods described in this book offer a sound foundation on which the reader may base his own technique."

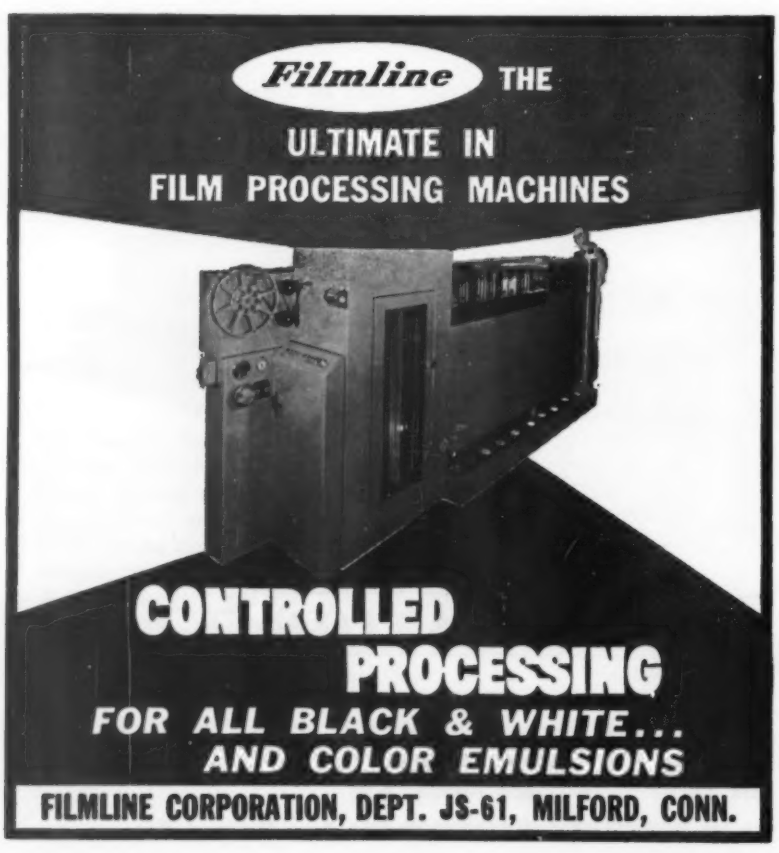
There are two further chapters. One is on "Image Assessment," which leads to the Rayleigh criterion and some data on eye and film characteristics. The final chapter is on "Illumination and Lens Systems," a field which is not always appreciated by designers of unconventional optical systems.

As has already been noted, the reader who masters this book cannot expect to design an $f/2$ photographic objective. But he will be able to do lesser tasks and will have achieved great insight into useful optical design.—*Pierre Mertz*, Lido Beach, L.I., N.Y.

Underwater Photography and Television

By Hans-Ulrich Richter. Published (1958) by Fotokino-Verlag, Halle (Saale), Germany. 337 pp. incl. bibliography. 321 illus. 35 tables. 5¾ by 8½ in. Price DM 38.

Underwater photography is no longer merely a hobby, but opens up the way for new scientific experiments in biology,



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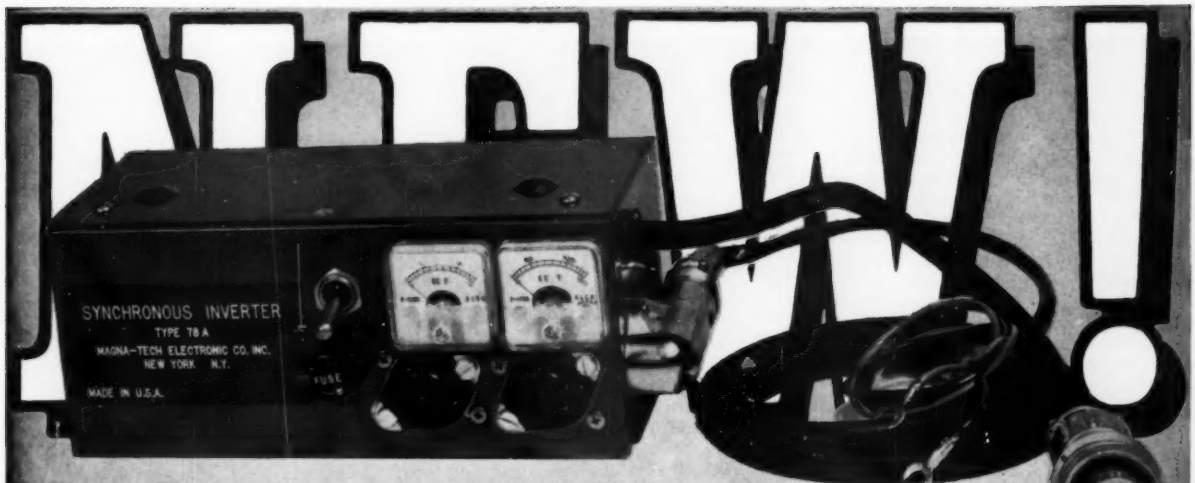

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oceanography and archaeology and other fields of science. Salvage service may be cited here as only one of its applications. The publication of this book, which presents a comprehensive discussion of the principles and practice pertaining to this field is a welcome addition to the literature. The author is a physicist and for many years has been an enthusiast of underwater photography. In addition, certain sections of the book have benefited from the assistance of other specialists.

The first part discusses the optical prerequisites of underwater photography. By means of numerous tables and diagrams, the book extensively describes the elemental legitimacy of the refraction of light, the reflection and the extinction. Part II describes equipment and the construction of underwater cameras, to conform to special requirements regarding hydrostatic pressure, corrosion, etc. Numerous illustrations show motion-picture and television cameras developed by various countries for special purposes. The practice of underwater photography, is discussed in relation to the apparent shortening of the path of light in the water and the resultant appearances; lenses used for the underwater photography; and film suitable for this purpose. Processing and the light sources are also discussed and necessary filters to be chosen in accordance with the special spectroscopical circumstances of the underwater photography, are described. Reducer formulae are given for the removal of too strong a blue component. Information is also given on swimming and diving techniques and on the use of the breathing devices. A supplementary bibliography with almost 800 references is included—*Dr. Karl Würstlin*, Kodak Aktiengesellschaft, Hedelfinger Strasse 54–60, Stuttgart-Wangen, Germany.

Control System Components

By John E. Gibson and Franz B. Tuteur. Published (1958) by McGraw-Hill Book Co., 330 W. 42 St. New York 36. 494 pp. incl. index. Illus. 6 by 9-in. Price $12.00.

"Transfer Functions of. . ." would have been a very apt and informative preamble to the title of this volume, since transfer function derivation is the major objective of this book. The authors have gathered together, from the literature, the largest existing collection of transfer functions for electronic, electrical, hydraulic and pneumatic control components. This has been achieved by concentrating on theoretical components, avoiding discussion of available hardware, and by avoiding entirely the analysis of complete closed-loop control systems and the associated mathematics. It is therefore necessary that the reader come equipped with a working knowledge of the Laplace transformation and a theoretical knowledge of control systems; if he happens to be an electrical engineer, that will help. This is especially true of the first chapter, where on page one the reader is introduced to the resistor, its construction and color code, and very soon thereafter is led (almost painlessly) through the stages of synthesizing RC and RL networks for particular transfer functions. This is all without reference to Foster or Cauer, and along the way he learns of the asymptotic representation of frequency response on a log-log scale, and by the end of Chapter One, has read one-eighth of the book.

Complete assimilation of Chapter One is, however, not necessary for the understanding of the rest of the book. In fact, many readers may prefer to go directly to the tables of schematic diagrams, transfer functions and associated frequency-response plots to be found in the chapters on mechanical and pneumatic controls, if that is where their main interest lies.

The reader who follows the authors' preferred approach will read the comprehensive analysis and discussion of d-c amplifiers in Chapter Two and will then proceed in order through the topics of a-c amplifiers, thyratrons, magnetic amplifiers, d-c machines, synchros, discriminators and a-c machines, and then on to the mechanical section. The analysis of mechanical components includes the treatment of spring, mass and dashpot combinations and leads to the discussion of a mechanical twin-T network and a lead network. Optimum inertial design of gear trains and a simple analysis of the gyroscope fill out the rest of the mechanical section. Both pump and valve-controlled hydraulic systems are treated next, and some analysis of hydraulic lines, orifices and valves is offered along with a discussion of the pulse-length modulation mode of valve operation. The pneumatic section offers a comparison between electrical, hydraulic and pneumatic systems and tabulates the analysis of a dozen pneumatic devices.

There is in this book something useful for all control engineers, and there is also something for all to bewail. Sensitive readers will be offended at the occasional inaccurate or somewhat irrelevant statement such as "Transistors cannot be used at high radio frequencies, but this is of no consequence in a control system" (p. 85). Practical readers will be unhappy that in the entire mechanical section there are no practical or numerical examples and not even a mention of an ounce, a gram or any other such practical unit. He might also note the absence of any discussion of laboratory measurement of transfer functions or reference to the treatment of nonlinear transfer functions. The authors are aware of some of their omissions and the somewhat arbitrary nature of their selection. They have, however, succeeded in adding to the literature yet another control system book—but one with a difference and a place.—*C. F. Knapp*, Technicolor Research Laboratory, Burbank, Calif.

A 4-page Short Form Catalog #860, available without charge from Allison Laboratories, Inc., 11301 E. Ocean Ave., LaHabra, Calif., describes several new instruments in addition to the regular line of filters, equalizers and analyzers. The catalog presents a brief description of each item, including the price. New products are the Model 532 Octave Band Analyzer, the Model 650 Random Noise Source, and the Model 201 Sub-Audio Variable Filter.

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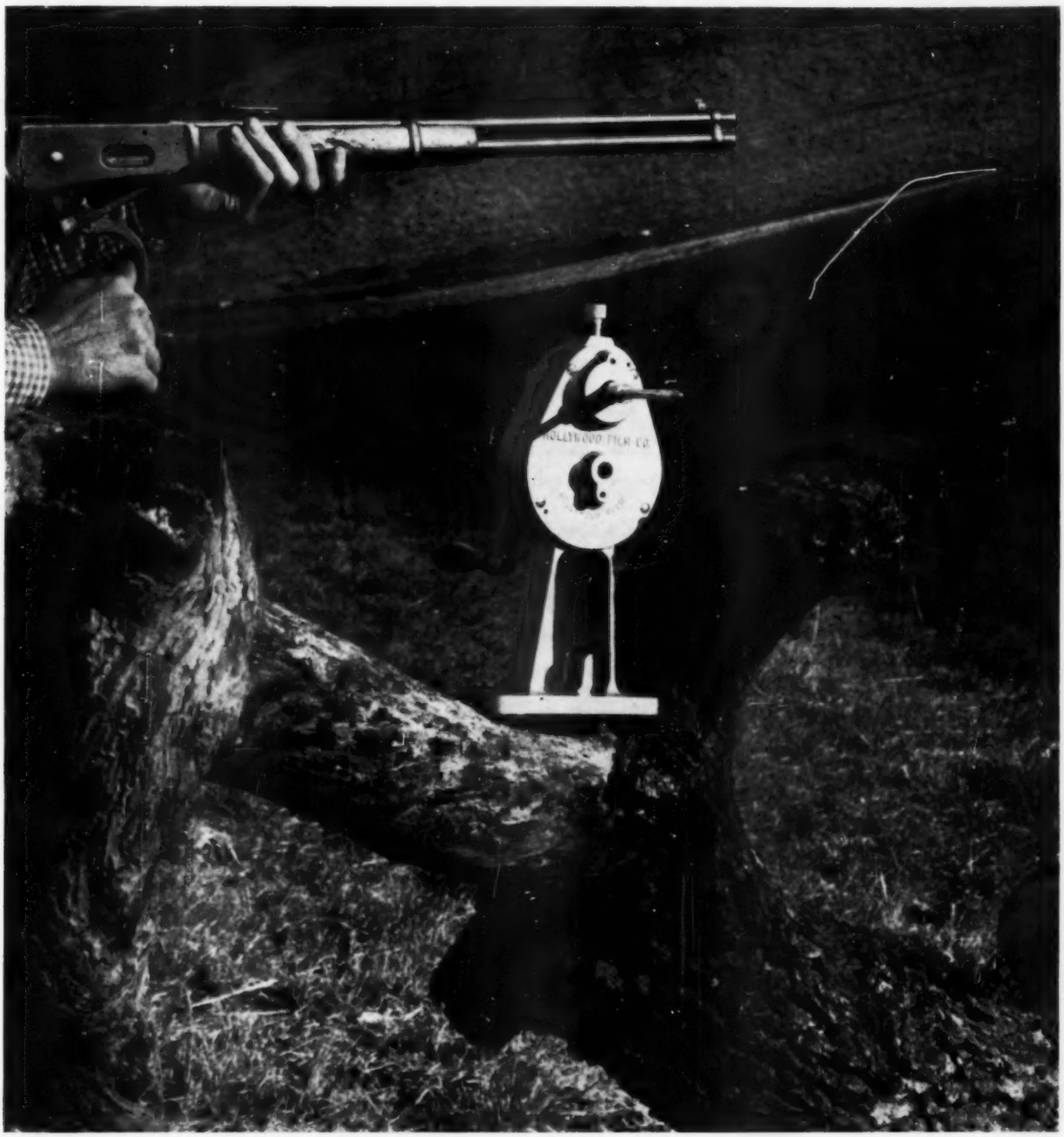

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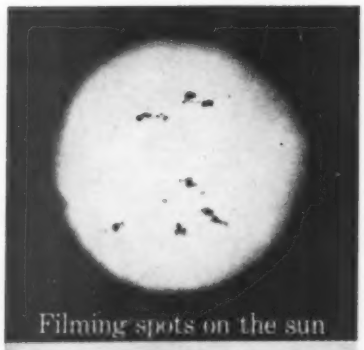

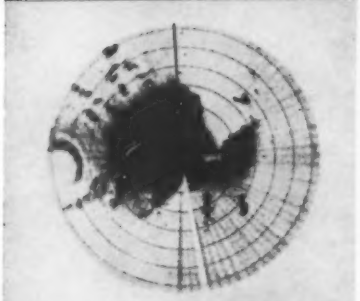

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New Members

The following members have been added to the Society's rolls since the April 1960 *Directory* and those listed in the September, November, February and May *Journals*. Also listed are those regretfully reported as deceased since the May listing.

Honorary (H) Fellow (F) Active (M) Associate (A) Student (S)

Deceased:

Frank V. Bremer (M)
Kenneth W. Colman (A)
Lee De Forest (H)
Emery Huse (F)
Lewis L. Mellor (M)
Clarence O'Malley (A)
A. J. Patel (A)
Harold J. Peterson (A)
Robert L. Powers (A)
A. A. Richardson (A)
Herman Roessle (M)
Burton H. Zucker (M)

Albert, D. B., Section Chief, Aerospace Corp. Mail: 10625 Second Ave., Inglewood, Calif. (A)
Ali, El Sayed, Research, Italian Cinemato. Labs, Via Acherusio 26 Int. 13, Rome, Italy. (M)
Angelo, Joe B., Project Eng., Purchasing Agent, Electronics Development Corp. Mail: 3743 Cahuenga Blvd., No. Hollywood. (M)
Apostol, Alexandre, Tech. Advisor, Commercial Dept., French Embassy. Mail: 8 Cresswell Gardens, London, S.W.5, Eng. (M)
Aranguren, Juan Francisco, Manager, Laboratorios Alex. Mail: Las Heras 1407—Martinez, Buenos Aires, Argentina. (A)
Aziz, John Paul, Royal Canadian Airforce. Mail: 223C Stanley Green Pk., Toronto, Ont., Can. (A)
Ball, Henry, Eng., Radio Corporation of America. Mail: 1511 W. Clark, Burbank, Calif. (M)
Bartley, G. A., Pres., CHCA-TV Ltd., Box 668, Red Deer, Alta., Can. (A)
Beckstrom, Stanley W., Chief, Chemical Contr., RCA Service Co. Mail: 6305 Sheri Dr., Huntsville, Ala. (A)
Bickerton, Richard A. M., Film Editor, Canadian Broadcasting Corp. Mail: 1637 Woodbine Heights Blvd., Toronto 16, Ont., Can. (A)
Birnbaum, Elisha, Free-Lance Sound Eng., 64 Witzman St., Givat-Rambam, Israel (A)
Blackwell, Tillie N., Optical Eng., Mergenthaler Linotype Co. Mail: 258 W. 22 St., New York 11. (A)
Blair, McClung Rhodes, Sales, Labcraft International Corp. Mail: 174 High St., Chagrin Falls, Ohio. (A)
Blake, Homer D., Mot.-Pic. Printing Supvr., U.S. Dept. of Agriculture. Mail: 904 Dashiell Rd., Falls Church, Va. (A)
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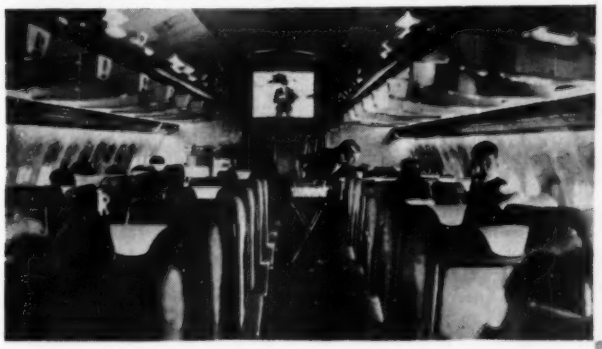

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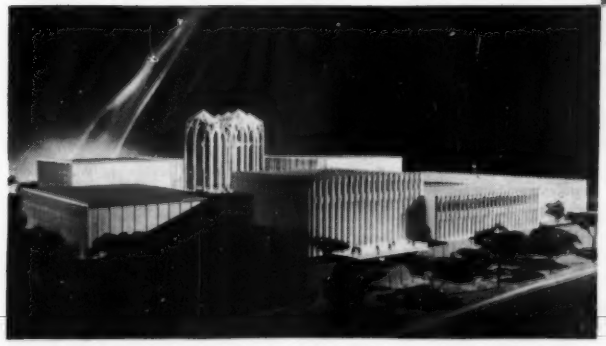

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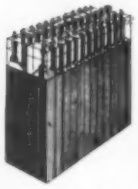

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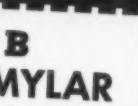

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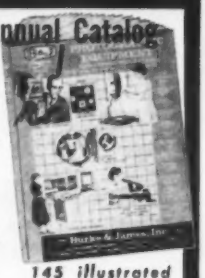

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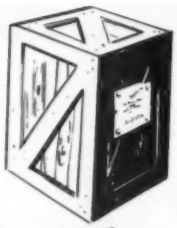

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Further information about these items can be obtained direct from the addresses given. As in the case of technical papers, the Society is not responsible for manufacturers' statements, and publication of these items does not constitute endorsement of the products or services.

The Spectra "Combi-500," an ultrasensitive exposure meter designed especially for use with high-speed films, has been announced by Photo Research Corp., 837 North Cahuenga Blvd., Hollywood 38. Design of the meter is based on a combination of a selenium cell and a newly developed extremely sensitive photoconductive cell. A tiny, easily accessible mercury battery is incorporated for use only with the ultra-sensitive range but is not required for normal exposure conditions. The firm has offered to convert any Spectra Professional Meter to the "Combi-500" for a nominal price.

A new color processor has been announced by Andre Debrie Mfg. Co., subsidiary of Belock Instrument Corp., College Point 56, Long Island, N.Y. Designed for compactness and economy, it is the same size as the firm's Aiglonne processor (*Journal*, p. 54, Jan. 1958). Tests on the new machine have established its ability to process Kodacolor 35mm and a series of tests is being conducted on Ektachrome 16mm, Anscochrome, and Anscochrome 16mm, which, according to the announcement, have so far indicated the "same results as. . . Kodacolor test."

Minor adjustments, involving changing chemicals and turning certain valves on or off, will enable the machine to process black-and-white as well as color. During final testing, Kodacolor was reported processed at rates and temperatures ranging from 40 ft/hr at 75 F to 80 ft/hr at 85 F with identical results. Developing times were from 12 min at slow speed to 8 min at top speed. The machine features automatic controlled replenishment and the estimated amount of chemicals required is 1 gal per 1000 ft. Temperatures are held to $\pm\frac{1}{4}°$ and speeds are variable. The 35mm model is priced at $4975 and the 16mm model is priced at $5550.

A laboratory instrument called the Hermes Precision Film Reader has been designed by the Special Equipments Division of Itek Laboratories, A Division of Itek Corp., 10 Maguire Rd., Lexington 73, Mass., for the analysis of photographs of nuclear tracks in bubble chambers. Recently announced as commercially available, the instrument is used for the semiautomatic conversion of photographic data to digital form. The instrument is said to be capable of being adapted for use in such fields as astronomy and satellite or missile tracking.

A new table model hot splicer, announced by Hollywood Film Co., 956 Seward St., Hollywood 38, handles 16mm or 35mm film on separate pins. The machine, called the FSC-13, is supplied with 0.072 splice width on 35mm and for A&B splice on 16mm, although any splice width can be supplied for either the 16mm or 35mm at no extra charge. The splicer is priced at $329.50.

Also announced is a Heavy Duty Torque Motor Rewind with double tightwind for winding 16mm or 35mm film in rolls up to 3000 ft. Used for film inspection, the machine can be stopped by hand without causing film damage. Film can be handled on reels or cores and a powerstat attachment is used to vary the speed. The machine is available with a toggle switch or foot control. It is priced at $240.

An ultra-high-speed flash source designed to provide a single point-source light pulse of high intensity with a duration as short as 0.3 μsec has been announced by Unilectron, Inc., 129 Binney St., Cambridge 42, Mass. The flash source, called Sync'd Submicrosecond Light Pulse Generator, is produced in four models to provide energy levels from 2 to 20 joules with durations from 0.3 to 1 μsec. The point source size ranges from 0.015 in. to 0.060 in. diameter, depending upon the

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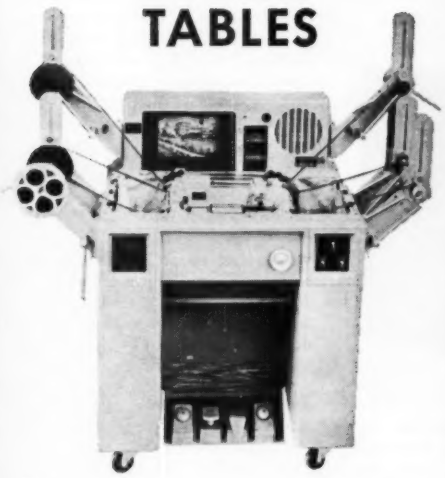

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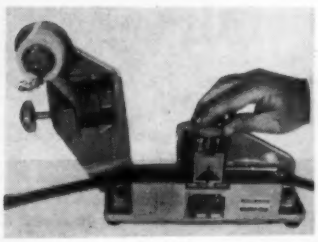
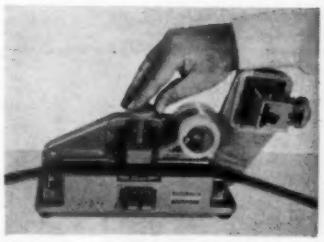


The cutting arm, shown in operating position, is used by pressing the chrome button for cutting both sides of the film simultaneously. The film, of course, has been registered on pins in the horizontal channel. The cutting blade is easily replaced when necessary.

The splicing tape is registered on precision pins and held in place until automatically applied to the film by swinging the arm over and pressing the chromed button. This action simultaneously cuts the adhesive and applies it — in perfect register to the film.



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- ☐ 66 ft. rolls — transparent 35mm (T-35) at $11.00
- ☐ 66 ft. rolls—white opaque—16mm—magnetic film only (0-16) at $6.00
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energy level. Designed for use with the firm's Nanosecond Kerr Cell Shutter, the light pulse output can be synchronized with a hypervelocity event and the opening of the shutter. Applications include schlieren and shadowgraph systems, carrier life testing of semiconductors, ballistic range photography and other events requiring a light pulse of an extremely short duration. The unit measures 12½ in. in length and 5 in. in diameter. It is priced at $900.

The Molenser, a spotlight designed for use in small theaters, TV studios, schools, etc., has been announced by Mole-Richardson Co., 937 North Sycamore Ave., Hollywood 38. The spotlight uses standard 1000- or 2000-w motion-picture globes and has a three-lens system consisting of two stationary lenses and one focusing lens. The spot size is controlled by an iris and a matt, used together or separately. The basic unit weighs 43 lb and is 39 in. long. It is priced at $325. Accessories, including pedestal, iris, matts, diffuser changer and diffuser frame are available at additional cost.

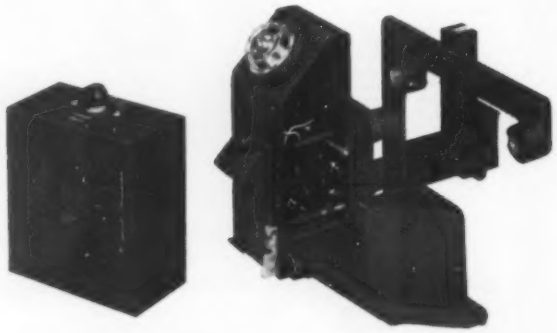
A portable transistorized magnetic recorder weighing only 59 lb has been announced by Smith & Cross Pty. Ltd., 161 Macpherson St., Bronte, N.S.W., Australia. Overall dimensions are 26½ by 16½ by 8¼ in. Designed especially for use on location as well as studio use, it has a film capacity of 1000 ft. The unit is available for either 17½mm film, operating at a rate of 90 or 45 ft/min, or 16mm at 36 ft/min. It can be run on single-phase or 3-phase supply. The amplifiers are operated from internal batteries, 18 v for record and playback and 15 v for the monitor amplifier. The film path is enclosed in a hinged cover and is protected from weather and dust. A relay switches the monitor circuits from record to relay when the motor starts. The recorder has two microphone inputs with high-level mixing, using solid molded carbon, bridged-T attenuators, with separate dialogue equalizers in each channel and a presence equalizer in the combined output. There is also provision for using a separate remote mixer.

A miniaturized experimental transistor described as being "so small that 20,000 can fit on a postage stamp" has been developed at the RCA David Sarnoff Research Center. The active material in the almost invisible transistor is cadmium sulfide. An evaporation process is used to deposit thin layers of cadmium sulfide and a metal on a glass plate. A special mask is used to cover portions of the plate during the process so that the metal layers are deposited in a pattern that forms the electrical contacts needed to operate the transistor. In operation the insulating properties of the cadmium sulfide hamper the flow of electrons between the two electrodes and the third element provides control by increasing the flow in varying degrees. Possible applications suggested in the announcement include "shrinking the basic circuitry of a computer to the size of a book page."

The Type BD 896 Vidicon Camera Channel produced by Marconi's Wireless Telegraph Co., Chelmsford, Essex, England, designed primarily for telecine and similar applications, is constructed so as to have a high degree of interchangeability with the BD 863 Image Orthicon Camera Channel. For purposes of maintenance, the picture and waveform monitor, camera control and power supply are identical. The channel may be switched from one to another of the three standards (405-, 525- and 625-line) and the aperture correction may be switched from and to 16mm and 35mm slide settings.

The TVC High-Definition Telerecorder announced by Taylor Video Corp., Lakeshore Studios, Toronto, Canada, features a fast pulldown camera to take the obscuring shutter splice out of the picture into the vertical blanking and thus eliminate the need for shutter correction. The picture tube has an infinite fine spot size for highest horizontal resolution and two variable spot wobbles for filling in blank spaces between the scanning lines. The machine has a three-section electronic gamma correction to allow individual correction of the white region, the black region, and the medium gray region.

Tiros III constructed, like its two predecessor weather satellites, at the Princeton, N. J., Space Center of RCA's Astro-



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Electronics Division under the supervision of Sidney Sternberg, is identical in size and shape to Tiros I and II, but incorporates some changes and additional equipment. Instead of carrying one wide-angle and one narrow-angle TV camera, the new Tiros carries two wide-angle cameras. It also carries an experimental infrared sensing system to measure heat radiation coming from the sun toward the earth and the amounts absorbed and reflected by the earth and its atmosphere. Tiros III has also been improved by the use of new transistorized circuits in the two electronic "clocks" which trigger the operation of the cameras and other equipment at any desired point in orbit in accordance with the program that is sent to the satellite as it passes within range of a ground station.

employment service

These notices are published for the service of the membership and the field. They are inserted three months, at no charge to the member. The Society's address cannot be used for replies.

Positions Wanted

Supervisory Photographic Technologist. Excellent instrumentation background obtained at four leading ordnance and missile Test Centers. Wide knowledge of cameras, lenses, mounts; including metric, engineering sequential, and documentary types. Broad film background. Supr. photo lab for 4 yrs. Purchasing and quality control background. Complete résumé upon request. Will relocate. Robert J. Millikin, 148 St. George Rd, Melbourne, Fla. PA 3-7819.

Cameraman/Producer. Extensive cine and still experience in training, public relations and industrial fields. Also experienced in cutting and sound recording. High-quality, low-budget script-to-screen producer. Interested in photo-instrumentation. Electronic engineering background. Recently completed Arctic assignment. Seeking challenging position in photography enabling use of past experience. Willing to travel and relocate worldwide. J.C.K., 3351 Alma St., Apt. 328, Palo Alto, Calif. DAvenport 6-2737.

Sound Recording Technician. Over 5 yrs experience in all phases of sound recording. Thoroughly familiar with mixing and recording sound for motion pictures, editing magnetic tapes and producing tapes for TV and radio. Interested in a permanent position with future. Willing to relocate. Thomas J. Hammeral, 137 92nd St., Brooklyn 9, N.Y. SH 5-7172.

Film Production Supervisor. 20 yrs experience in motion-picture and general photographic production. Presently in supervisory position in large inplant unit. Experienced in documentary, training and P.R. film productions. Do "A & B" cutting and sound recording. Hold Secret and "Q" Clearances. Resume upon request. Would consider Tech. Rep. position. Mo-pic, P.O. Box 9123, Montclair Station, Denver 20, Colo.

Credit and Office Manager Accountant. Efficient executive administrator, systems developer, personnel training and customer relation setups. Eight years film laboratory experience. Highest credentials. Résumé upon request. S. C. Robbins, 315 East 196 St., New York 58.

Position in engineering department of motion-picture laboratory or equipment manufacturer. Thirty years experience as supervisor in Engineering Department of Consolidated Film Ind., Fort Lee, N.J. Experience includes machine shop, construction and maintenance of printers, developing machines and other film equipment. Also assisted in design and development. Irving Fox, 3214 Kingsbridge Ave., Bronx 63, N.Y.

Positions Available

Assistant Chief Engineer. Seeking college graduate electronics engineer to assist Chief Engineer of commercial VHF television station in growing market. CBS affiliate; progressive management with long broadcast experience; good record of low personnel turnover. Majority of equipment RCA; two Ampex Videotape Recorders; maximum power; 1000-ft tower. Applicant should be capable of doing design and construction work, and should have some administrative ability. Salary commensurate with experience and ability. Replies treated in confidence. Write Chief Engineer, WLAC-TV, Nashville, Tenn.

Sales Representative for well known motion-picture processing laboratory, N.Y.C. Experienced in laboratory processes, motion-picture production, sound recording and re-recording operations. Must be able to deal with professional cameramen, producers and directors in the advertising and educational fields. Salary open. Unusual opportunity for advancement. Outstanding company benefits. Send résumé in complete confidence, including salary desired, to: Hokar Corp., 110 West 40 St., New York, N.Y.

Assistant to Owner of Film Lab. Unusual opportunity for man who is expert in timing and printing 16mm color and black & white. Must also have basic knowledge of general business practices and be endowed with the ability to lead and supervise. Write to CINE-CRAFT, 8764 Beverly Blvd., West Hollywood 48, California.

Staff Director, for medium-sized production company located in Louisville, Kentucky. Must have credits for TV commercials, industrials and slidefilms. Basic requirement is a creative attitude. We offer unlimited opportunities, pay in accord with experience, and an expanding company with which to be associated. Although location work is to be expected, off hours are pleasantly spent in this friendly, midwestern community. All replies are held in confidence. Vogue Film Productions, Inc., Bowman Field, Louisville, Ky.

Motion-Picture Laboratory Engineer. Experienced in lab procedures, design and maintenance of motion-picture lab equipment. Knowledge of air conditioning, chemical piping and pumps desirable. Located New York City. Send resume giving experience and salary desired to Box 1979, 125 West 41 St., New York 36.

Television Broadcast Technician. Seeking experienced, qualified television technician for maintenance and operation at commercial VHF

station in growing market. CBS affiliate; progressive management with long broadcast experience. Station is well-equipped; maximum power; 1000-ft tower; two Ampex Videotape Recorders. Applicant must be ambitious, dependable, and have First-Class Phone License. Some formal schooling in electronics preferred. Salary commensurate with experience and ability. Replies treated in confidence. Write Chief Engineer, WLAC-TV, Nashville, Tenn.

Photographic Instrumentation Technicians. Opportunities for qualified technicians exist in the Pacific Island area assisting in the operation of the Pacific Missile Range. Requirements: High level of technical competence, good moral character, single, widowed, or divorced (no housing presently available for married applicants). Position offers good pay, overtime premium, broad technical experience, chance for advancement with progressive company. Technical areas open: Operation maintenance of Askania theodolites, LA-24 (ME-16), M-45 tracking telescopes and high speed sequential cameras. Electronics capability very desirable. Positions also available for Photo Laboratory Technicians. Wide experience in all phases desirable. Ample opportunity for cross training in related fields. Many fringe benefits. Please submit resume to: Vought Range Systems Div., P.O. Box 51, Naval Missile Center, Pt. Mugu, Calif. Attn: H. S. Weisbrod, Photo-Optics Supervisor.

Cameraman. Prefer man with considerable experience on Mitchell cameras. Midwest producer with fine reputation and financial standing wants man with ability and experience in lighting sets and operating camera on all kinds of interior and exterior photographic assignments. Job involves very little travel. Write giving full details of past and present employment and salary expected. Technisonic Studios, Inc., 1201 Brentwood Blvd., St. Louis 17, Mo.

Chemist-Photographic. Civil Service. Grade GS-11. Starting salary, $7560. In Photogrammetry Division, Photographic Service Branch. Involves establishing procedures in controlling quality of chemicals. Mail Form 57 (available at any post office) to Aeronautical Chart and Information Center, Attn. Mr. R. J. Gast, ACDPS, Second and Arsenal Sts., St. Louis 18, Mo.

Journals Available/Wanted

These notices are published as a service to expedite disposal and acquisition of out-of-print Journals. Please write direct to the persons and addresses listed.

Available

Transactions. Ten volumes, Nos. 19 through 34. Write: William C. Kunzmann, 2992 West 14 St., Suite 2, Cleveland 13, Ohio.

Index 1936–1945; Mar.–Sept., Nov., Dec. 1947; Jan., Feb., Sept., Nov., Dec., Index Jan.–June 1948; Jan., Mar. & High-Speed Photography, Apr.-July, Index Jan.–June, Sept.–Dec., Index July–Dec. 1949; Jan.-Oct., Dec., Indexes Jan.–Dec. 1950; Jan.–Apr., June, July, Sept.–Dec., Indexes Jan.–Dec. 1951; Jan.–July, Index Jan.–June 1952; Jan.–Aug., Nov., Dec., Indexes Jan.–Dec. 1953; Jan.–June, Aug.–Dec., Indexes Jan.–Dec. 1954; Jan.–Dec. & Index 1955; Jan.–Dec. & Index 1956; Jan., Mar. 1957; Jan., Apr. 1958. Available as entire lot for $100. Camille Buyse, 1232 Chaussee de Wavre, Auderghem-Brussels 16, Belgium.

Jan. 1936 through Mar. 1957, except Mar. 1942 and Jan. 1945. Send offer to: R. S. Parris, 29 Charles St., Natick, Mass.

Assortment of Journals, from 1937 through 1950. Write: Alan Cook, South Londonderry, Vt.

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Complete set of Journals March 1937 through May 1954. Best offer. A. R. Ulmer, 69 Cresskill Ave., Dumont, N. J. DU 4-8656.

Complete set of Journals January 1949 through December 1960, inclusive, including high-speed, special issues, indexes, directories, etc., in excellent condition. For sale as entire lot only. Leslie Helhena, P. O. Box 643, Burbank, Calif.

Complete set of Journals from January 1934 through June 1960. Excellent condition. For sale only as a set. Write: Don Norwood, 1470 San Pasqual St., Pasadena, Calif.

Complete set of Transactions, except Nos. 6 and 9, and all Journals published to date, including indexes. All in good condition. Price $500. Also extra copies of Transactions Nos. 21, 31, 32. W. W. Hennessey, RFD #2, Pound Ridge, N. Y.

Complete set of Journals from May 1937 to June 1954, including special volumes and membership directories, excellent condition; also Mar., May 1934 and July 1935 issues. Write: Harry R. Lubcke, 2443 Creston Way, Hollywood 28, Calif. HO 9-3266.

Jan-Dec. 1950; Jan., Feb., Apr.-Dec. 1951; Jan-Mar. 1952. Also available are vols. 6 and 7 of The Television Society (British) covering the period Jan. 1950 through Sept. 1955. Write: Andrew N. McClellan, 65 Hillside Drive, Toronto 6, Ont., Canada.

Dec. 1946, Feb.-Dec. 1947, 1948–1955 complete. All copies in perfect condition; for sale as entire lot only. Write: Joseph W. MacDonald, 2414 Sullivant Ave., Columbus 4, Ohio.

Jan. 1947 to Dec. 1957 complete and in perfect condition. For sale only as a set. Write: Charles J. Marshall, 2816 Royalston Ave., Kettering 19, Ohio.

Complete set of Journals Jan. 1949 to Dec. 1958. Perfect condition. What offers? Write: J. G. Jackson, 210 Kingsway South, Port Alberni, B. C., Canada.

Wanted

Jan., July, Sept. and Nov. 1949; Jan and Feb. 1950. Century Lighting, Inc. (Mrs. Levine), 521 W. 43 St., New York 36, N.Y.

Feb., Mar., Apr., June 1934. Mrs. Janet Van Duyn, Librarian, CBS Laboratories, 227 High Ridge Rd., Stamford, Conn.

Journals—Bound volumes. Write: S. P. Solow, Consolidated Film Industries, Inc., 959 Seward St., Hollywood.

Transactions 6 and 9 ($15 each offered). W. W. Hennessey, RFD #2, Pound Ridge, N.Y.

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Résumés / Resumenes / Zusammenfassungen

The Society wishes to thank the Eastman Kodak Company for providing, through the agency of John Flory, translations into all three languages of the abstracts of all the 8mm papers in this issue. The Society is also grateful to the following authors of other papers for supplying translations: K. Blair Benson—*German;* J. S. Courtney-Pratt—*French, Spanish, German;* and to Pablo Tabernero for his continued assistance.

L'avenir du film sonore de 8mm

JOHN FLORY [581]

De la même façon que les éditions "bon marché" ont agrandi le champ des éditeurs, le film sonore de 8mm, "une autre pierre angulaire dans la révolution des communications" peut étendre les frontières du cinéma. Cependant, il faut vaincre des grands obstacles techniques et économiques avant de pouvoir se rendre compte de tout ce qui peut apporter le cinéma de 8mm dans les champs des amusements et du service aux sciences, à l'industrie et à l'enseignement.

Les premiers travaux de sonorisation 8mm

WILLIAM HEDDEN et KENNETH B. CURTIS [585]

Dernièrement on a vu augmenter l'intérêt et l'activité dans l'usage des films sonores de 8mm. Cependant, il ne faut pas oublier les grands travaux de recherche faits au temps passé par ceux intéressés dans les films de 8mm. Cet article présente un résumé historique du travail effectué par feu M. Lloyd Thompson et quelques de ses premières recherches. On appelle surtout l'attention sur les appareils de projection sonore qu'il a introduits et sur quelques méthodes de traitement du film qu'il a utilisées pour faire des copies.

Problèmes du dessin d'un projecteur pour film de 8mm avec sonorisation magnétique (Réimpression)

LLOYD THOMPSON [588]

Projecteur petit à écran postérieur pour film de 8mm avec sonorisation magnétique

R. G. HENNESSEY [590]

Le film magnétique de 8mm possède des propriétés qui lui permettent une duration exceptionnelle aussi bien que de l'économie initiale pour son adaptation. On présente les avantages des appareils en comparaison avec ceux existants auparavant. On explique aussi avec détail les diverses applications des appareils de 8mm.

Le film sonore de 8mm vu par un éducateur

LOUIS FORSDALE [593]

La mise au marché du film sonore de 8mm fait prévoir du progrès important pour le cinéma dans l'enseignement. Ce progrès comprend l'emploi toujours croissant des bibliothèques (cinémathèques) décentralisées, l'utilisation plus grande du film par des groupes petits, ou par les élèves mêmes, l'accroissement des listes de sujets, des nouveaux usages dans la recherche et mise en production des possibilités locales. Cependant, beaucoup de ces avantages dépendent absolument de pouvoir trouver des projecteurs et visionneuses plus simples, plus légers et meilleur marché, et des appareils améliorés pour faire du cinéma 8mm.

Le film de 8mm et la bibliothèque aux écoles: ce qu'il peut faire, ce qu'il lui faut

STEVE KNUDSEN [595]

A présent, la pratique de routine pour l'emploi du cinéma aux écoles consiste à louer les films, avoir des salles de projection et emprunter des projecteurs. On se demande donc: le 8mm, peut-il être l'agent pour changer cela de façon à former une bibliothèque à l'école avec les films et tout ce qu'il faut pour projecter restant à l'école même comme partie des classes? Si la réponse est affirmative, quelles seront les conséquences de ce changement? Qu'est-ce-qu'il faut faire avant que cette transformation s'opère?

Enregistreur d'une pièce pour cinéma sonore

WILLIAM V. STANCIL [597]

Des nouvelles techniques pour faire du cinéma exigent des appareils petits pour la sonorisation. On décrit ici un enregistreur d'une seule pièce, utilisant un ruban et des transisteurs et activé par des piles. Cet enregistreur permet la synchronisation avec des appareils à ressort ou à moteur. L'enregistreur, pesant un peu plus de 5 kilos, peut être employé avec des appareils de 35, 16 ou 8mm. Le son qui en résulte peut se transférer sur du film denté, pour permettre la revision, ou bien il peut être synchronisé avec des projecteurs pour le cinéma à double système.

Inspection rapide des copies à sonorisation magnétique

BEN KLEINERMAN [600]

On enregistre une onde sinuée à basse fréquence (30 cycles) en même temps que l'audio quand on fait la copie. Ce son peut alors être entendu pendant l'inspection à grande vitesse (120 mètres par minute) pour découvrir d'autres défauts physiques. Des relais activés par thyratron font arrêter la machine en cas d'interruption, épissure ou diminution dans le volume du signal qui indiqueraient une altération dans la piste du son. L'observateur peut alors recommencer à une vitesse de 24 images par seconde et écouter pour découvrir des effasures ou enregistrements doubles.

Rapport sur le progrès des copies positives 8mm en couleurs avec sonorisation magnétique

ROBERT A. COLBURN [603]

Il y a presque 25 ans qu'on a fait des copies par réduction sur films silencieux 8mm en couleurs. L'amélioration constante dans les méthodes et les matériaux en ont permis beaucoup d'usages commerciaux. Quoique déjà en 1947 on avait présenté pour la première fois à notre Societé un papier sur la sonorisation magnétique 8mm, pas beaucoup de progrès a été visible jusqu' à la fin de 1959. Le Laboratoire Geo. W. Colburn a adapté les appareils existants et en a projeté et construit des nouveaux pour faire face à la demande de bonnes copies 8mm en couleurs, en grande quantité et à un prix beaucoup plus bas que celui des copies 16mm. On y est arrivé malgré le nombre d'opérations additionnelles nécessaires.

Comment on fait des copies 8mm chez Technicolor

W. E. POHL [606]

Ce papier décrit les méthodes employées chez Technicolor pour préparer des copies 8mm avec sonorisation magnétique à base de Film Négatif Eastman Color 35mm ou de l'Ektachrome 16mm.

Progrès dans les bandes magnétiques sur film sonore de 8mm

EDWARD SCHMIDT [607]

L'idée d'appliquer une couche de matériel magnétique sur le bord d'un film cinéma a été patentée en Amérique en 1919. Cependant, ce n'est que dernièrement qu'on a pu la commercialiser en film de 8mm. En effet, on n'a réussi à fabriquer des bons projecteurs sonores 8mm qu'après l'introduction de matériel magnétique à longue duration et des éléments électroniques petits et bon marché. La maison Soundcraft a fabriqué deux machines pour couvrir le film avec une couche de bandes magnétiques, le premier appareil pour traiter le film vierge de 16mm et le second pour appliquer la couche au film de 8mm déjà traité.

Bandes magnétiques de précision sur film 8mm

F. J. KOLB, JR., R. C. LOVICK, J. R. PEER et E. M. WEIGEL [611]

L'enregistrement de son magnétique sur film de 8mm exige beaucoup d'exactitude par rapport aux dimensions de la bande et au fonctionnement magnétique—audio, parce que le système demande une bande étroite et un film à sensibilité basse. Dans cet article on examine ce qu'il faut pour faire un bon dessin d'une machine à mettre les bandes. On appelle surtout l'attention au placement du film positif et de la bande au point où elle est mise, à la vitesse constante du film et aux tensions minima de celui-ci. On y décrit un dispositif pour appliquer la couche et une dispersion magnétique de haute viscosité qui, combinés, déterminent la largeur, l'-paisseur et le contour de la bande. Ce système a été employé par Eastman Kodak Company depuis mai 1960 pour enduire le Sonotrack sur film 8mm; les data sur la qualité résultant de cette opération indiquent un bon contrôle sur la production. On présente des techniques d'atelier pour servir de guide aux laboratoires de traitement voulant suivre des systèmes similaires pour mettre la bande.

Sonorisation photographique sur film 8mm

JOHN A. MAURER [618]

La sonorisation photographique pour le cinéma de 8mm présente un avantage de prix comparée avec le système magnétique dans toutes les applications qui demandent un grand nombre de copies. Au contraire de ce qu'on croit généralement, la sonorisation photographique peut produire des résultats aussi bons au moins que la méthode magnétique. On y décrit un système de démonstration qui emploie un Projecteur Magnétique Sonore Kodak de 8mm, modifié pour reproduire la sonorisation photographique, et on en donne les data sur le fonctionnement.

Une tireuse d'épreuves à réduction de 16mm à 8mm de type continu et à grande vitesse

KENNETH B. CURTIS et WILLIAM D. HEDDEN [624]

Les épreuves de tirage de 8mm de qualité optimum s'obtiennent généralement par réduction directe à partir de négatifs de 16mm. La plupart des tireuses pour réduction à 8mm sont

du type par degrés fonctionnant à des vitesses relativement lentes. Le présent mémoire décrit une tireuse optique continue d'épreuves de 8mm, qui fonctionne à une vitesse de 250 pieds par minute (76 m/min.) Les avantages de qualité du tirage à réduction sont combinés avec les avantages de production du tirage continu. L'appareil utilise des pignons dentés sur un axe entraîneur du type courant, ainsi qu'un système optique en forme d'U.

Techniques de conversion aux normes de télévision CBS

K. Blair Benson [628]

L'avènement de la bande-image a fourni un moyen pour l'échange intercontinental rapide de programmes de télévision où le délai de transmission n'a pas besoin d'être supérieur à la durée du trajet d'un avion à réaction de type moderne. Toutefois, la différence entre les paramètres d'exploration d'image utilisés par les divers pays empêche souvent la diffusion du signal-image sous sa forme initiale et nécessite une conversion aux normes de transmission appropriées. L'auteur explique les problèmes relatifs à la construction des convertisseuses employées à cette fin, et décrit les appareillages utilisés par la CBS.

Des sources lumineuses de haute intensité à microsecondes fractionnaires

Philip Nolan [632]

On a perfectionné des sources de lumière à haute intensité en vue d'applications dans le réglage optique du tir, les communications et la navigation. Ces sources produisent uneétincelle électrique de surface restreinte qui a un éclat maximum d'environ 50 millions de bougies par cm^2 et une durée de 0,5 μ sec ou moins.

Ces étincelles peuvent être produites à des fréquences résonnantes ou être déclenchées avec précision au moyen d'électrodes de déclenchement. Il est possible d'obtenir, dans certaines conditions, des fréquences normales de fonctionnement allant jusqu'à plusieurs kilocycles. Les mesures spectrographiques indiquent une température effective de corps noir de l'ordre de 30.000 K. Parmi les travaux de recherches effectués ont figuré des essais avec des atmosphères d'étincelles de compositions et pressions diverses.

Une nouvelle technique pour mesurer la vitesse des objects en parcours rapide

Donald A. Hall et W. W. Atkins]634]

Une nouvelle technique pour la mesure des vitesses des particules, projectiles, modèles ou autres masses sur trajectoire contrôlée a été mise au point en vue de son emploi au laboratoire dans l'étude des phénomènes balistiques. Un des principaux avantages de ce système réside dans le fait que le vitesse d'objets isolés dans toute l'étendue d'un ample spectre de vitesse peut être mesurée pour toute position donnée de lancement de l'accélérateur.

Le système utilise une caméra à stries Fastax de type normal comme porte-film. Des champs lumineux collimatés sont disposés le long de la trajectoire que le projectile ou la particule doit suivre. Une fente verticale et étroite, près de la trajectoire et perpendiculaire à celle-ci, fait fonction d'obturateur à submicrosecondes quand le produit de la multiplication de la désamplification de l'image par la vitesse de déplacement du film égale ou approche la vitesse de l'objet. Une série de miroirs fait tourner l'image de fente de 90°, ce qui permet au champ lumineux de produire une exposition en forme de ruban sur toute la longueur du film. Un projectile, à son entrée dans le champ lumineux, crée une ombre instantanée à la fente et est enregistré sous cette forme sur le film. Ceci se répète à deux ou plusieurs emplacements judicieurement espacés le long de la trajectoire. Vu que les images de projectile et les jalons à base de temps sont produits simultanément, il suffit simplement de mesurer le déplacement de l'image et de déterminer la vitesse de déplacement du film pour pouvoir calculer le vitesse de l'objet.

Cinématographie ultra-rapide pour rayons X

J. S. Courtney-Pratt [637]

On s'est préoccupé ici des techniques de dissection d'images. Une petite caméra de dissection d'image avec optique utilisant petites fibres de verre a été construite. Elle est capable de prendre dix images consécutives à une vitesse allant jusqu'à 100.000 images/seconde, à lumière visible. On espère pouvoir l'employer avec autant de succès pour la prise de vues d'images de rayons X à des vitesses égales.

El reto que impone la película sonora de 8mm

John Flory [581]

De igual modo que el uso de las tapas de papelhan ampliado el campo editorial, la película sonora de 8mm "nuevo acontecimiento en la evolución del sistema de comunicaciones," sin duda extenderá los linderos de la industria cinematográfica. Todavía hay que vencer ciertos obstáculos serios de carácter técnico y económico antes de poder realizar por completo el potencial de que es capaz la película de 8mm como medio de recreo en el hogar y en los servicios de la comunidad, religión, medicina, ciencia, industria, gobierno y educación.

Acontecimientos anteriores en sonido para 8mm

William D. Hedden y Kenneth B. Curtis [585]

Si bien es cierto que últimamente ha despertado gran interés y se nota mucha actividad en el campo de películas sonoras de 8mm después de haber lanzado al mercado varios proyectores sonoros de 8mm, no hay que olvidar que en el pasado, aquellos interesados en este material ya habían conducido infinidad de investigaciones y pruebas. Este escrito presenta un resumen histórico de las labores que ejecutó el Sr. Lloyd Thomson. Se presta particular atención al equipo de provección sonora que lanzó al mercado, y también a ciertos procedimientos relativos a la película que utilizó para hacer las copias o duplicados que ofrecía al público.

Problemas en el diseño de un proyector para película de 8mm con banda sonora magnética (Reimpresión)

Lloyd Thompson [588]

Proyector manuable con pantalla posterior para película de 8mm con banda sonora magnética

R. G. Hennessey [590]

La película de 8mm con banda magnética no solo posee propiedades que contribuyen a su excepcional vida útil, sino que también proporciona economía inicial en la adaptación. Describe las ventajas de este equipo en relación a los aparatos que se ofrecían con anterioridad. Contiene los resultados de los rodajes de prueba que se llevaron a cabo para verificar la vida útil del material, además de los resultados de otras pruebas. Detalla las aplicaciones a que puede adaptarse el equipo de 8mm.

Un profesor examina la película sonora de 8mm

Louis Forsdale [593]

El advenimiento de la película sonora de 8mm sugiere un adelanto importantísimo de este medio en el campo educativo, que incluye el uso más acelerado que da lugar la descentralización de las bibliotecas de película, aumento en el uso de las mismas por grupos pequeños, individuos que prefieren instruirse por sí solos, nuevos usos para la investigación y aprovechamiento de las posibilidades de producción locales. Sin embargo, infinidad de estos adelantos dependen decisivamente de la disponibilidad de equipos, proyectores y visores de un diseño más simple, livianos y económicos, y también de las mejoras que puedan introducirse en las cámaras sonoras de 8mm.

La película de 8mm en relación a la biblioteca de películas para el salon escolar: Potenciales y requisitos

Steve Knudsen [595]

Nuestra norma actual en el uso de película educativa implica el alquiler de la misma, disponibilidad de salones de proyección especiales y de proyectores ambulantes. ¿Sería posible convertir la película de 8mm a un agente que cambie esto a una norma por medio de la cual pueda uno contar con cierta biblioteca de películas adecuada, y también con facilidades de proyección que sean parte integrante del salón escolar? ¿Qué es lo que se debe hacer antes de poder poner en vigor dicho cambio?

Grabador integrado para sonido en películas cinematográficas

William V. Stancil [597]

Las nuevas técnicas de producción de película cinematográfica requieren ahora cámaras y equipos sonoros manuables. Se describe un grabador de cinta integrado que funciona por medio de baterías y transistores; proporciona sincronización tanto con cámaras propulsadas por cuerda como por motor. Este grabador, que pesa 13 libras (6 Kg) puede usarse en unión de cámaras de 35mm, 16mm u 8mm, y el sonido que capta puede transferirse a película perforada, ya sea para propósito de editar o bien para hacer otras cópias o duplicados; puede sincronizarse con los proyectores, para conseguir el sistema de doble visión.

Inspección super-rápida de duplicados con banda magnética

Ben Kleinerman [600]

Al hacer la cópia o reproducción de la película se hace registrar una onda senoidal de baja frecuencia (30 ciclos) simultáneamente con la audiofrecuencia. Esta señal puede entonces distinguirse durante la inspección ultrarrápida (400 pies/minutos) de otros defectos físicos. Los relevos accionados por el sistema Thyratron detienen la marcha del aparato en caso de que algo haya quedado omitido, ode un empate o reducción en el nivel de la señal de salida, lo que significa que ha ocurrido cierta alteración en la banda sonora. El operario puede entonces comenzar de nuevo a 24 cuadros por segundo para verificar si ha ocurrido una borradura objetable o regrabación.

Duplicados positivos de 8mm en color con banda magnética: Un informe de progreso

Robert A. Colburn [603]

Casi 25 años atrás ya se habían hecho duplicados reducidos mudos de 8mm en color. Mejoras introducidas constantemente tanto en los métodos como en los materiales han conducido a infinidad de aplicaciones para usos comerciales. Si bien en el año 1947 por primera vez se le ofreció a la Sociedad un escrito tocante a la película magnética sonora de 8mm, no se observó casi ningún adelanto significativo sino hasta en los últimos meses de 1959. Los Laboratorios Geo. W. Colburn adaptaron el equipo disponible y también idearon y fabricaron nuevos equipos

para atender la demanda por duplicados en cantidad de película sonora en color de 8mm, no sólo de buena calidad sino también a un costo bastante más reducido de lo que resultaban las copias en película de 16mm, a pesar de las operaciones extra que esto implica.

La fabricación de copias de 8mm por Technicolor

W. E. Pohl [606]

Se discuten los métodos que emplea la Cía. Technicolor en la preparación de copias de películas de 8mm con sonido magnético, de Negativos de Color Eastman de 35mm, o bien a base del material Ektrachrome de 16mm.

Progreso en lo relativo a la banda magnética sonora de 8mm

Edward Schmidt [607]

Si bien la idea de aplicar una banda de material magnético en la orilla de la película cinematográfica dió motivo a patentes americanas en el año 1919, no fué sino hasta últimamente que se ha descubierto un sistema práctico que permite producirlas comercialmente en la película de 8mm. El éxito logrado por los proyectores sonoros de 8mm fué realizado únicamente después que se idearon los cabezales magnéticos de alta precisión y de calidad durable, sin olvidar aquellos componentes electrónicos compactos y de costo más reducido. La Cía. Soundcraft se ha dedicado a la fabricación de dos máquinas para poner bandas magnéticas a la película—una que aplica la capa al material vírgen de 16mm; la otra para aplicar la capa a la película procesada de 8mm.

Aplicación precisa de la banda magnética de 8mm

F. J. Kolb, Jr., R. C. Lovick, J. R. Peer y E. M. Weigel [611]

El grabar sonido magnético en película de 8mm requiere observar tolerancias muy precisas, tanto en las dimensiones de la banda como en el rendimiento audio-magnético, pues dicho sistema requiere una banda estrecha y una velocidad de rodaje lenta. Se repasan los requisitos esenciales de una máquina bien diseñada para aplicar estas bandas, y se da particular atención a la posición positiva de la película y ubicación de la banda en el punto donde debe aplicarse, propulsión constante en la velocidad de rodaje de la película y tensiones mínimas de la misma. Se describe un cabezal para aplicar la capa, así coma la correspondiente dispersión de alta viscosidad magnática que mancomunadamente definen la anchura de la banda, su espesor y contorno. Este sistema lo tiene en práctica la Cía. Eastman Kodak desde mayo de 1960; los datos compilados por el control de calidad relativos a las pruebas manifestaron un magnífico control de producción. Se describen las técnicas de esta operación con la mira de que puedan servir de guía a aquellos laboratorios de procesar que deseen diseñar sistemas parecidos.

Banda foto-sonora para película de 8mm

John A. Maurer [618]

Las bandas foto-sonoras para películas cinematográficas de 8mm ofrecen una ventaja decisiva en lo relativo a costo, al compararlas con bandas magnéticas cuya aplicación requiere la producción, en cantidad, de duplicados o copias. Contrario a la creencia general, las bandas foto-sonoras son capaces de producir una calidad a lo menos tan buena como la de las bandas sonoras magnéticas. Se describe y proporcionan datos de cumplimiento pertenecientes a un sistema de demostración en el que se usó un Proyector Kodak Magnético Sonoro de 8mm modificado para reproducir bandas foto-sonoras.

Una reductora continua de alta velocidad para reducir de 16mm a 8mm

Kenneth B. Curtis y William D. Hedden [624]

Copias de explotación en 8mm de calidad óptima se obtienen, generalmente, mediante la reducción directa a partir de negativos de 16mm. La mayor parte de las reductoras de 16 a 8mm son del tipo intermitente y trabajan a velocidades relativamente bajas. El presente artículo describe una reductora óptica, continua, para 8mm que funciona a una velocidad de 250 piés/minuto. En ella se combinan las ventajas de una alta calidad de la copia reducida con las de una producción elevada, obtenida por el proceso de copia continua. Se utilizan rodillos dentados, montados sobre un eje comùn, y un sistema óptico en forma de U. (*Tr. de Pablo Tabernero*).

Normas de televisión CBS para técnicas de conversión

K. Blair Benson [628]

El advenimiento de cinta video ha proveido un medio para el cambio intercontinental rápido de programas de televisión en lo cual la demora de transmisión no necesita exceder el tiempo de viaje de un aeronaveje: moderno. No obstante, la diferencia entre parametros escandidores de imagenes empleados por las naciones varias frecuentemente impide la emisión de la señal video en su forma original y necesita una conversión a las normas apropriadas de transmisión. Se discute unos problemas relativos al diseño de convertidores para este objeto y se describe los equipos usados por CBS.

Unas fuentes luminosas de alta intensidad a microsegundos fraccionarios

Philip Nolan (632)

Se han perfeccionado unas fuentes luminosas de alta intensidad para unas aplicaciones militares en el arreglo óptico de tiro, comunicaciones y navagación. Estas fuentes producen una chispa eléctrica de superficie restringida que tiene una cresta máxima de 50 millones de bujías approximadamente por cm² y una duración de 0.5 microsegundos o menos.

Estas chispas pueden ser producidas a unas frecuencias resonantes o ser disparadas con precisión por medio de electrodós disparadores. Es posible de obtener, bajo ciertas circunstancias, unas frecuencias normales de funcionamiento alcanzando hasta muchos kilociclos. Las medidas espectrógraficas indican una temperatura efectiva de cuerpo negro del orden de 30.000 K. En los trabajos de estudios efectuados se han incluido unos ensayos de varias composiciones y presiones.

Una tecnica para medir la velocidad de unos objectos en vuelo rapido

Donald A. Hall y W. W. Atkins [634]

Una técnica nueva para la medida de particulas, proyectiles, modelos o otra masas en trayectoria reprimida ha sido desarrollada para uso de laboratorio en el estudio de unos fenomenos balisticas. Ina de las ventajas principales de este sistema reside en la realidad que la velocidad de objetos aislados por todo un espectro ancho de velocidad puede ser medido para cualquiera posición de lanzado del acelerador.

La sistema usa un cámara á huellas Fastax de tipo normal como transporte-película. Unos campos luminosos colimados son colocados á lo largo de la trayectoria que el proyectil o la particula debe seguir. Una raja vertical y estrecha, pegada á la trayectoria y perpendicular á ella, hace función de obturador á submicrosegundas cuando el producto de la multiplicación de la desamplificación de la imagen por la velocidad del desplazamiento de la película iguala o aproxima la velocidad del objeto. Una serie de espejos hace girar la imagen de la raja de 90°, que permite al campo luminoso de producir una exposición en forma de centa sobre toda de la largura de la película. Este se repete á dos o diversos emplazamientos juiciosamente espaciados á lo largo de la trayectoria. Visto que las imagenes de proyectiles y los jálanes de base de tiempo son producidos simultanéo. Es suficiente simplemente de medir el desplazamiento de la imagen y de determinar la velocidad de desplazamiento de la película para poder calcular la velocidad del objeto.

Radiocinematografía ultrarrápida

J. S. Courtney-Pratt [637]

Para esto se han tenido en cuenta varias técnicas de disección de imágenes, construyéndos al efecto una pequeña cámara para la disección de óptica fibrosa, la que puede sacar en secuencia diez fotografías a promedios de hasta 10^6/segundo empleando luz visible. Se espera sea igualmente adecuada para registrar secuencias de radiografías a promedios similares.

Die Zukunft des 8mm Tonfilms

John Flory [581]

Genau wie die Taschenbücher das Feld der Veröffentlichungen sehr erweitert haben, wird wohl der 8mm Tonfilm, "ein weiterer Meilenstein in der Revolution der menschlichen Verständigung," das Gebiet der Kino-Industrie erweitern. Einige wesentliche technische und wirtschaftliche Hindernisse müssen jedoch noch überwunden werden, bevor man sich der Verwendungsmöglichkeiten voll be wusst wird, die der 8mm Tonfilm für Wissenschaft, Schulwesen, Wirtschaft, Industrie und allgemeinen Gebrauch bietet.

Frühes Entwicklungsstadium des 8mm Tonfilms

William D. Hedden und Kenneth B. Curtis [585]

Obgleich man neuerdings infolge der Einführung mehrer 8mm Tonfilmprojektoren dem 8mm Tonfilm bedeutend regeres Interesse entgegenbringt, sind auch in der Vergangenheit viele Forschungen und Weiterentwicklungen durchgeführt worden von Leuten, die an 8mm Filmen interessiert waren. Dieser Bericht gibt eine historische Zusammenfassung über die Arbeit von Lloyd Thomson und seinen frühen Entwicklungen. Besondere Aufmerksamkeit ist der Tonfilmausrüstung gewidmet, die er eingeführt hat, sowie seinen Regeln der Filmtechnik und Arbeitsmethoden, die er angewandt hat, um Massenkopien zu bekommen.

Probleme bei der Bauart eines 8mm Magnettonfilm-Projektors (Ein Nachdruck)

Lloyd Thompson [588]

Filmprojektor mit eingebauter, transparenter Lichtbildwand für 8mm film mit magnetischem Tonstreifen

R. G. Hennessey [590]

Der 8mm Magnettonfilm ist sowohl dauerhaft als auch preiswert. Auch die Filmausrüstung ist besser im Vergleich zu früher benutzten Apparaten Es werden Resultate von Tests angegeben, die zur Prüfung der Dauerhaftigkeit des Films durchgeführt ;wurden. Verschiedene Anwendungsmöglichkeiten der 8mm Tonfilmausrüstung werden in Einzelheiten beschrieben.

Ein Pädagoge betrachtet 8mm Tonfilm

Louis Forsdale [593]

Die Entwicklung des 8mm Tonfilms bringt bedeutende Neuerungen für das Erziehungs- und Schulwesen mit sich. Zahlreichere Filmo

theken und eine grössere Anzahl von Filmen werden den Gebrauch steigern und werden auch kleineren Gruppen und Einzelpersonen die Filme zugänglich machen. Auch in Wissenschaft und Wirtschaft erweitert der 8mm Tonfilm die Forschungsmöglichkeiten. Viele dieser Fortschritte hängen jedoch noch davon ab, dass man genügend einfachere, leichtere und preiswertere Projektoren und 8mm Tonfilm-Kameras zur Verfügung hat.

8mm Tonfilme und die Schulfilmothek: Bedarf und Möglichkeiten

STEVE KNUDSEN [595]

Zur Zeit werden in den Schulen Filme und projektoren meistens ausgeliehen und man benutzt extra Projektionsräume. Kann der 8mm Tonfilm dazu führen, dass eine ausreichende Filmothek und die dazugehörigen Projektionsmöglichkeiten zum festen Bestandteil einer Klasse werden? Was würde solch eine Neuerung mit sich bringen und was müsste noch dafür getan werden?

Ein unabhängiges Tonfilm-Aufnahmegerät

WILLIAM V. STANCIL [597]

Die neue Filmtechnik erfordert solide, kleine Kameras und gute Tonausrüstung. Es wird ein unabhängiges Tonbandgerät mit Batterien und Transistoren beschrieben, welches Synchronisation von Kameras mit Motor—oder Federantrieb ermöglicht. Das etwa 6 kg schwere Tonbandgerät kann mit 35 mm, 16 mm oder 8mm Kameras benutzt werden, und der entstandene Ton kann auf die perforierte Filmrolle übertragen werden, um den Gesamtschnitt einer fertigen Kopie zu erhalten. Dieses System schliesst auch Nachsynchronisierung für Doppelfilm ein.

Geschwindigkeitsüberwachung von Magnettonfilmen

BEN KLEINERMAN [600]

Eine Sinusschwingung mit einer Tiefenfrequenz von 30 Hz wird bei der Aufnahme der Tonfrequenz mit aufgenommen. Diese Sinusschwingungen kann man dazu benutzen, um das Band bei hoher Geschwindigkeit (122 m/Min.) auf physikalische Defekte zu untersuchen. Thyratron-betätigte Relais halten die Maschine an, sobald sich irgendwelche Defekte wie Spleisstellen, Tonausfälle usw. einstellen. Man kann dann das Band noch einmal mit der Normalgeschwindigkeit von 24 Bildern/Sek. ablaufen lassen, um nicht einwandfreie Stellen zu verbessern.

8mm Farb-Positivfilm mit Magnettonband: Ein Bericht des Fortschritts

ROBERT A. COLBURN [603]

8mm farbige Stumm-Schmalfilme wurden schon vor fast 25 Jahren hergestellt. Dadurch, dass Filmtechnik und Material laufend verbessert wurden, hat der Film in der Wirtschaft vielfältige Verwendung gefunden. Obgleich schon 1947 ein Bericht über 8mm Magnettonband herausgegeben worden war, konnte man bis 1959 keinen grossen Fortschritt erzielen. Das Geo. W. Colburn Laboratorium übernahm vorhandenes Material und entwarf und baute neues Filmmaterial, um hochwertige 8mm Ton-Farbfilme zu bedeutend geringerem Kostenaufwand als die 16mm Filme herzustellen, obgleich das Verfahren natürlich komplizierter war.

Die Bearbeitung der 8mm Filme bei Technicolor

W. E. POHL [606]

Hier werden die Methoden besprochen, mit denen Technicolor die 8mm Magnettonfilme bearbeitet, die von 35mm Eastman Farb-Negativen oder 16mm Ektachrome hergestellt sind.

Fortschritte bei der Magnetschichtbegiessung des 8mm Tonfilms

EDWARD SCHMIDT [607]

Obgleich die Idee, den Rand eines Spielfilms mit einer Magnetschicht zu versehen, schon 1919 in Amerika patentiert wurde, konnte man es bis vor kurzem für den 8mm Tonfilm nicht kommerziell durchführen. 8mm Tonfilmprojektoren wurden erst mit der Erfindung von sehr präzisen, dauerhaften Magnetköpfen und nicht zu teuren, soliden elektronischen Bestandteilen möglich. Von der Firma Soundcraft sind zwei Maschinen zur Magnetschichtbegiessung von Filmen hergestellt worden, die eine für unbelichtete 16mm Filme und die zweite für entwickelte 8mm Filme.

Präzise Magnetschichtbegiessung des 8mm Films

F. J. KOLB, JR., R. C. LOVICK, J. R. PEER und E. M. WEIGEL [611]

Die Magnettonaufnahme auf 8mm Filme muss mit besonderer Sorgfalt durchgeführt werden, da das System einen schmalen Streifen und geringe Filmgeschwindigkeit erfordert. Die Hauptfaktoren, die bei einer guten Magnetbegiessungsmaschine zu beachten sind, sind genaue Platzierung des Films, präzise Begiessung, möglichst konstanter Bandzug und ein Minimum an Spannung. Ein Beschichtungskopf und ein entsprechend hoher Visikositätsgrad der Magnet-Zerstreuung werden beschrieben, die gemeinsam die Breite, den Umfang und die Schichtlinien des Streifens bestimmen. Dieses System ist seit Mai 1960 von der Eastman Kodak Co. für 8mm "Sonotrack" Tonfilmbegiessung benutzt worden. Laufende Qualitätskontfollen zeigen gute Produktionsergebnisse. Für Laboratorien, die ähnliche Begiessungssysteme entwickeln möchten, sind Arbeitsanleitungen gegeben.

Licht-Tonaufnahme für den 8mm Film

JOHN A. MAURER [618]

In Bezug auf Kosten bietet das Tonband mit Lichttonaufzeichnung für 8mm Spielfilme merkliche Vorzüge im Vergleich zu Magnettonspuren mit allen Anwendungsmöglichkeiten, von denen man eine grosse Anzahl von Ansichtskopien braucht.

Im Gegensatz zur allgemeinen Auffasung, können Tonbänder mit Lichtonaufzeichnung qualitätsmässig mindestens ebenso gute Ergebnisse erzielen wie Magnettonspurstreifen. Ein Vorführungssystem mit einem Kodak 8 mm Magnetophon-Film Projektor, der für die Wiedergabe photografischer Filmbahnen eingerichtet wurde, ist beschrieben, einschliesslich Leistungsangaben.

Eine kontinuierliche Verkleinerungskopiermaschine hoher Geschwindigkeit für 16 mm zu 8mm

KENNETH B. CURTIS und WILLIAM D. HEDDEN [624]

Im allgemeinen erhält man 8mm Vertriebskopien bester Qualität mittels der direkten Verkleinerung von 16mm Negativen. Die Mehrzahl der 8mm Verkleinerungskopiermaschinen sind vom intermittenten Typ und arbeiten mit einer verhältnismässig geringen Geschwindigkeit. Der vorliegende Bericht beschreibt eine kontinuierliche optische Kopiermaschine für 8mm., welche mit 250 Fuss per Minute läuft. Es verbinden sich hier die qualitativen Vorteile der Verkleinerungskopie mit den Vorteilen für die Produktion, die das kontinuierliche Verfahren mit sich bringt. Es werden Zahntrommeln mit gemeinsamen Antriebsschaft und ein optisches System mit U-förmigen Lichtweg benutzt. (*Üb. von Pablo Tabernero*).

CBS-Fernseh-Normwandlung-Verfahren

K. BLAIR BENSON [628]

Mit der Erfindung des magnetischen Fernseh-Aufzeichnungsgerätes ist die Möglichkeit für unmittelbaren Austausch von interkontinentalen Fernseh-Programmen geschaffen worden, wobei die Ubertragungs-Verzögerung nicht mehr betragen darf als die Reisezeit eines modernen Düsen-Flugzeuges. Jedoch, der Unterschied zwischen Bildabtastung-frequenzen der verschiedenen Ländern lässt es nicht zu das Fernsehsignal in der Original Form zu senden und es muss daher in die nötwendigen Normen umgewandelt werden. Die Probleme im Zusammenhang mit dem Entwurf de Normwandler und die Geräte im Gebrauch bei CBS werden ausführlich behandelt und beschrieben. (*Üb. von W. G. Connolly*).

Hochintensitäts-Lichtquellen für Mikrosekunden-Bruchteile

PHILIP NOLAN [632]

Zur militärischen Verwendung beim optischen Entfernungsmessen, zur Nachrichtenübermittung und für die Schiffahrt wurden hochintensive Lichtquellen entwicklet. Sie liefern einen elektrischen Funken in kleinem Raum, der eine Spitzenhelligkeit von ca. 50 Millionen Kerzenstärken/cm² und eine Dauer von 0,5 Mikrosekunden oder darunter hat. Diese Funken können entweder bei Resonanzfrequenzen betrieben oder, mit Hilfe von Auslöseelektroden, genau ausgelöst werden. Unter gewissen Umständen sind normale Frequenzen bis zu mehreren Kilohertz möglich. Spektrographische Messungen zeigen eine wirksame Schwarzkörpertemperatur von ca. 30.000 Kelvin. Zu den Entwicklungsarbeiten gehörten auch Experimente mit Funkenatmosphären verschiedener Gase und Drücke.

Eine neue Methode der Geschwindigkeitsmessung von Hochgeschwindigkeitsobjekten.

DONALD A. HALL und W. W. ATKINS [634]

Zum laboratoriumsmässigen Gebrauch bei der Untersuchung ballistischer Erscheinungen wurde eine neue Methode der Geschwindigkeitsmessung von Partikeln, Projektilen, Modellen und anderen Massen mit geregelter Flugbahn geschaffen. Ein Hauptvorteil dieses Systems ist der, dass die Geschwindigkeit einzelner Objekte bei jedem einzelnen Abfeuern des Beschleunigers durch ein breites Geschwindigkeitsspektrum gemessen werden kann.

Das System benützt eine normale Fastax Schlierenkamera als Filmtransport. Entlang der vom Projektil oder Partikel zu durchlaufenden Strecke werden kollimierte Lichtfelder angeordnet. Ein enger vertikaler Schlitz, nahe der Flugbahn und senkrecht zu ihr, bildet einen Verschluss für weniger als eine Mikrosekunde, wenn Bildverkleinerung mal Filmfortbewegung gleich oder nahe der Geschwindigkeit des Objekts sind. Eine Reihe von Spiegeln, die das Schlitzbild um 90° verdreht, gestattet es dem Lichtfeld, entlang der ganzen Filmlänge eine bandförmige Belichtung zu produzieren. Ein in das Lichtfeld eindringendes Projektil wirft sofort einen Schatten auf den Schlitz und wird als solcher am Film aufgenommen. Dies wiederholt sich bei zwei oder mehreren sorgfältig angeordneten Stationen entlang der Flugbahn. Da die Bilder des Projektils und die Merkpunkte für die Zeitgundlage gleichzeitig produziert werden, ist es nur nötig, die Bildverlagerung zu messen und die Geschwindigkeit der Filmbewegung zu bestimmen um die Objektgeschwindigkeit errechnen zu können.

Kurz-Zeit Röntgenstrahl-Kinematographie

J. S. COURTNEY-PRATT [637]

Bildzerleger-Methoden sind in Betracht gezogen worden. Eine kleine Bildzerlegerkamera mit Faseroptik ist hergestellt worden. Eine Reihenfolge von 10 Bildern mit einer Bilderzahlgeschwindigkeit bis zu 10^8/Sekunde bei sichtbarem Licht kann damit erzielt werden. Erwartungsgemäss könnte es auch für die Aufnahme von Reihenfolgen von Röntgenstrahlbildern mit ähnlichen Geschwindigkeiten Verwendung finden.

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Meeting Calendar

American Chemical Society, National Meeting, Sept. 3–8, Chicago.

IRE, National Symposium on Space Electronics and Telemetry, Sept. 6–8, Albuquerque, N.M.

PGIT, International Symposium on Transmission and Processing of Information, Sept. 6–8, MIT, Cambridge, Mass.

AIEE, ISA, IRE, Joint Nuclear Instrumentation Symposium, Sept. 6–8, North Carolina State College, Raleigh, N.C.

IEE, Microwave Measurements Techniques, Conference and Exhibition, Sept. 6–8, Savoy Plaza, London, England.

ISA, Fall Instrument-Automation Conference and Exhibit, Sept. 11–15, Memorial Sports Arena, Los Angeles.

Electronic Industries Association, Annual Meeting, Sept. 12–14, New York.

Standards Engineers Society, Annual Meeting, Sept. 18–20, Hotel Sherman, Chicago.

IRE, AIEE, Industrial Electronics Symposium, Sept. 20–21, Boston, Mass.

American Physical Society, Meeting, Sept. 24–25, Univ. of Chicago.

AICE, National Meeting, Sept. 24–27, Lake Placid Club, Lake Placid, N.Y.

Illuminating Engineering Society, National Technical Conference, Sept. 24–29, Chase-Park Plaza Hotel, St. Louis, Mo.

Electrochemical Society, Fall Meeting, Oct. 1–5, Statler Hotel, Detroit, Mich.

IRE, Canadian Electronic Conference, Oct. 2–4, Automotive Bldg., Exhibition Park, Toronto, Ont.

90th Semiannual Convention of the SMPTE, Oct. 1–6, Lake Placid, N.Y.

American Rocket Society, Twelfth International Astronautical Congress, Oct. 2–7, Washington, D. C.

National Electronics Conference, Oct. 9–11, International Amphitheatre, Chicago.

American Rocket Society, Space Flight Report to the Nation, Oct. 9–15, New York Coliseum, New York.

American Standards Association, National Conference, Oct. 10–12, Rice Hotel, Houston, Texas.

AIEE, Fall General Meeting, Oct. 15–20, Statler-Hilton Hotel, Detroit.

ASCE, Annual Meeting, Oct. 16–20, Hotel Statler, New York.

Optical Society of America, Fall Meeting, Oct. 18–20, Biltmore Hotel, Los Angeles.

Acoustical Society of America, Meeting, Nov. 9–11, Cincinnati and Dayton, Ohio.

Air Force Office of Scientific Research, Second International Conference on the Exploding Wire Phenomenon, Nov. 14–16, Boston, Mass.

ASME, Annual Meeting, Nov. 26–Dec. 1, Hotel Statler, New York.

Society of Reproduction Engineers, Visual Communications Congress, Dec. 1–4, Hotel Biltmore, Los Angeles.

AICE, Annual Meeting, Dec. 3–7, Hotel Commodore, New York.

American Association for the Advancement of Science, Annual National Meeting, Dec. 26–31, Denver Hilton, Brown Palace, Cosmopolitan, Shirley Savoy Hotels, Denver, Colo.

AIEE, Winter General Meeting, Jan. 28–Feb. 2, 1962, Hotel Statler, New York.

AICE, National Meeting, Feb. 4–7, 1962, Statler-Hilton, Los Angeles.

American Society of Photogrammetry, Annual Convention, Mar. 11–17, 1962, Washington, D. C.

IRE International Convention, Mar. 26–29, 1962, New York.

91st Semiannual Convention of the SMPTE, Apr. 29–May 4, 1962, Ambassador Hotel, Los Angeles.

SPSE Annual Conference, May 7–11, 1962, Somerset Hotel, Boston, Mass.

6th International Congress on High-Speed Photography, Sept. 17–22 1962, Hotel Kurhaus, Scheveningen, Netherlands.

92nd Semiannual Convention of the SMPTE, Oct. 21–26, 1962, Drake Hotel, Chicago.

93rd Semiannual Convention of the SMPTE, Apr. 21–26, 1963, Traymore Hotel, Atlantic City, N.J.

94th Semiannual Convention of the SMPTE, Oct. 13–18, 1963, Somerset Hotel, Boston.

SMPTE Officers and Committees: The rosters of the Officers of the Society, its Sections, Subsections and Chapters and of the Committee Chairmen and Members were published in the April 1961 Journal.

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